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THE UNIVERSITY OF ALBERTA

Factors Influencing Capital Formation in Subsistence Agriculture

by

Ananta Kumar Mainaly

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF Master of Science

IN

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Department of Rural Economy

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Fall 1988

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled Factors Influencing Capital Formation in Subsistence Agriculture submitted by Ananta Kumar Mainaly in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE in AGRICULTURAL ECONOMICS.

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Supervisor

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Date 29 07 88

Dedicated to my Mother

Dev Kumari Mainaly

Abstract

The main objective of this study is to test the hypothesis that the level of public capital influences private capital formation in the subsistence agricultural sector of a developing country. The other objectives are to determine: (a) the effect of public capital on agricultural production, (b) economic rationale for expenditure on public capital, and (c) the distributional effect of public expenditure in public capital according to caste and literacy. Two regions in Nepal, with similar agroclimatic conditions but different levels of public capital facilities, were selected to obtain the empirical evidence. Seventy one farm families with similar land holdings were surveyed. Private capital formation, agricultural production and the social rate of return of public expenditure in the less developed and developed regions were compared. The production function approach of finding the sources of growth and social rate of return, developed by Griliches, was used to test the hypotheses.

The elasticities of private capital formation and agricultural production with respect to public capital are found to be 0.28 and 0.13 respectively and are statistically significant. These results show the importance of public capital in private capital formation and in agricultural production in the subsistence agricultural sector of a developing country. The economic rationale for public capital formation is justified by the 418 and 222 percent social rate of return of public capital in the less developed and developed regions respectively. Public expenditure on public capital is observed to be biased towards the higher caste and literate farm families.

It is concluded that the formation of public capital, in the less developed region of a developing country, is a prerequisite for the formation of private capital and for agricultural growth and development. Public expenditure should be directed towards the least developed rural areas to maximise the social rate of return from limited financial resources within similar agroclimatic regions. Public capital should be formed evenly within areas of similar economic potential.

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I. INTRODUCTION

Capital has been the "pivot" variable in growth economics. Growth economists have proposed several models based upon capital (Harrod, Domar, Solow, Swan, etc.). Almost all growth economists agree on the central role of capital in economic growth and development. In recognition of the importance of capital in economic growth and development, capital formation has been one of the main subject matters in development economics.

Capital formation has been studied in general and at the sectoral level. Historically, public capital had been one of the main stimulating factors in the formation of private capital (Rosenstein-Rodan, 1944; Nurkse, 1954; Cairncross, 1962a). Hirschman, the leading advocate of the unbalanced growth doctrine, developed a model and showed a two way causation (positive) relationship between private capital formation and public capital formation. However, in a less developed region of a developing country, Hirschman argued, public capital formation is a prerequisite in the formation of private capital. Without considering Hirschman's assumptions, it appears obvious that the formation of private capital in a less developed region of a developing country is possible simply by the formation of public capital. The connection is not that obvious, because the relationship between private and public capital formation is behavioral rather than technical. The relationship between private and public capital being behavioral, the applicability and predictability of Hirschman's model may not be universal. In different circumstances the relationship may be different. Hirschman's model is a general model. It does not say under what circumstances and in which sector it is applicable. In this study, the applicability of Hirschman's model in a subsistence agricultural sector will be tested and the factors that influence the formation of private capital of subsistence farmers will be explored.

To test Hirschman's model and to explore the factors influencing private capital formation in a subsistence agricultural sector, an empirical study in a less developed district, Surkhet, of a developing country, Nepal, is performed. The Surkhet District of Nepal is selected as a study area mainly because it gives an opportunity to determine the contribution of foreign aid, specially Canadian aid, to the development of the subsistence agricultural

sector of Nepal.

Foreign aid is the main financial source in the developmental program of Nepal. Foreign aid has been accounting for more than 44% of Nepal's development budget since the country started its first development plan in 1956 (Appendex III). In the early sixties, India and the United States were the two main donor countries of Nepal. In the seventies and onwards as the developed countries, at least in principle, agreed to donate one percent of their national income in aid to the developing countries, Nepal started getting aid from many more developed countries, Canada being one of them. For this reason, the amount of foreign aid in Nepal has increased significantly. In the present plan (7th plan), foreign aid accounts for almost seventy percent of Nepal's development budget. The development program of Nepal depends upon the foreign aid it receives. The development budget of Nepal and the amount of foreign aid are highly correlated. The correlation coefficient between these two variables is 0.977[1].

Nepal has already completed six development plans. In all the plans agriculture was always on the priority list. However, the economic indicators do not show any signs of development in its agricultural sector. Since 1970, the per capita agricultural output, labour productivity and land productivity have decreased significantly (FAO, 1986). All economic indicators show the failure of the general plan of His Majesty's Government of Nepal to develop its agricultural sector. However, Surkhet District is different in terms of its agricultural program.

Surkhet is one of the districts of Nepal where the government with the co-operation of the Canadian government has implemented integrated rural development (IRD) called the Karnali Bheri Integrated Rural Development (K-BIRD) Program. Prior to 1979 there was hardly any public capital in the villages of this district. Table 1.1 shows the public capital situation before and after the implementation of IRD in Surkhet District.

---

[1] The Correlation cofficient was calculated with the help of the realised yearly budget of Nepal from 1965/66 to 1984/85 and estimated budget of 1985/86 and 1986/87.

Capital formation and agricultural production by farm families in the areas with relatively higher amounts of public capital vis-a-vis areas with lower amounts of public capital can provide useful information. On the one hand the information may be used to test the applicability of development models for subsistence agriculture. On the other hand it may provide useful information to planners. The nature of the impact of public capital on private capital formation and agricultural production may improve the economic base for the government of Nepal for all its agricultural programs, which are currently unsuccessful.

The productivity of labour in the agricultural sector of Nepal has decreased over time (FAO, 1986). The productivity of a factor of production goes down if it is over-utilized in the production process or when other factors are under used. The main factor responsible for the reduction of labour productivity may be under-utilization of capital in the production process (Furtado, 1963).

Whether the farmers in Surkhet District are using enough capital to increase labour productivity or not is difficult to determine. The rate of capital formation, however, can be determined as well as factors influencing that formation. The ability of the farmers to save and to finance capital improvements, the willingness of the farmer to invest, and the availability of public capital facilities could explain the rate of capital formation. Following Schultz (1964), the farmers in this study are assumed to be rational. The willingness of farm families to invest in capital is assumed. The other two factors, availability of public capital and ability to save, are the subject of this research.

In the past, public capital had been one of the main stimulating factors in private capital formation (Cairncross, 1962a; ECAFE, 1961; Shukla, 1968; Nurkse, 1954; Rosenstein-Rodan, 1944). There is also some evidence, mainly in underdeveloped countries, showing no positive relationship between private capital formation and public capital formation (Goil, *et. al.* 1971; Mukerji, 1971). The question in this research is whether formation of public capital stimulates farm families to accumulate capital. The factors that are explored in this study are: (a) ability of the farmers to save and the formation of capital by them. (b) the availability of public capital and its effect on private capital formation of

the farmers.

According to Northrup (1947), the problem can be of three types, *logical consistency of theory, empirical truth of theory or problem of value*. In this case there is a problem of logical consistency of the theory, because the factors responsible in the formation of private capital in a subsistence agricultural sector of a developing country are not well understood. There is insufficient empirical evidence on private capital formation in the subsistence agricultural sector of a developing country to achieve this understanding. This research addresses the problem of empirical truth. Value judgements are minimized in the research design and the approach to farmers for evidence.

Considering these factors, the hypothesis of this study is: A significant problem for private capital formation and agriculture growth and development in a subsistence agricultural sector of a less developed region of a developing country is the lack of public capital.

The hypothesis of this study is related to the formation of public capital and its contribution to private capital formation and to agricultural production. Does public capital play any role in the formation of private capital? Does public capital have any effect on agricultural production? What is the effect of public capital on factors of agricultural production? If public capital has a positive effect on private capital formation and agricultural production, is it factor and socially neutral? These are the questions that are to be answered in this study.

Objectives of the Study

(a) The primary objective of this study is to test the hypothesis that the level of public capital influences private capital formation in the subsistence agricultural sector of a developing country.

(b) The second objective is to estimate the effect of public capital on agricultural production.

(c) The third objective is to determine the economic rationale of public capital formation.

(d) And the fourth objective is to determine the distributional effect of expenditure on public capital formation according to caste and literacy.

Plan of the Study

The rest of this chapter is devoted to a brief introduction to Nepal, K-BIRD and Surkhet District. Methodology of the study is presented in the second chapter. Review of literature, hypotheses arising from the theory and specification of the model is presented in chapter three. The results are presented in the fourth chapter. The final chapter presents the summary and the conclusions of this study.

Introduction to Nepal, K-BIRD and Surkhet District

Nepal: Nepal is a small land locked developing country with 14.1 million hectares of land. Only 16.5 percent of its area is under cultivation and an additional 10 percent may be brought into cultivation (ADB/HMG, 1982). More than 93 percent of its 17 million peoples are employed in agriculture. As a result Nepal's economy is totally based upon agriculture.

Physically, Nepal may be divided into three regions, the gangetic plain (tarai), the hills and the mountain regions. The distribution of land in the tarai, hills and mountain regions is 22%, 44% and 33% respectively. The tarai region, which is a narrow strip of land between the hills and India accounts for nearly 52% of the Nepal's cultivated land. The hilly region constitutes the middle part of Nepal, which accounts for nearly 48% of the total cultivated land and 56% of the population. The mountain region is in the Northern part of Nepal, which is not suitable for agricultural production, because most parts of the moutain region are under perpetual snow. The three regions run east west parallel to each other.

For political and administrative purposes Nepal is divided into five regions, fourteen zones, and seventy five districts. Each district is divided into several village and town panchayats depending upon the level of development and population. The village panchayats are divided into nine wards, whereas division of the town panchayats into wards depends upon the size of the population. The five regions of Nepal are named according to their geographic location as, eastern region, central region, western region, mid-western region and far-western region. The eastern and the central regions are relatively more developed than their western counterparts. A better agroclimate and a greater share of the public expenditure are the two

main factors enhancing the development of these regions. The government of Nepal only started paying attention to the western regions in the late eighties. The mid-western and far-western regions especially were isolated from the main stream of development. In a country of nearly 800 miles length, the mid-western and far-western regions are still remote areas of Nepal.

IRD & K-BIRD: Among other programs, Canada finances an integrated rural development program in two of the most remote zones of Nepal. The Karnali and Bheri Zones are in the mid-western development region of Nepal. The five districts of Karnali Zone are in the mountain and lower mountain regions, whereas, three districts of Bheri Zone are in the hilly region and the remaining two are in the tarai region.

In the month of March 1978 a group of experts headed by a Canadian planning and liaison officer started to collect information to plan the K-BIRD program. In June 1978, the field work was completed, and by January 1979 the plan was ready. The plan was prepared for the sixth (1980-1985) and seventh (1985-1990) five-year plan of Nepal. To "*bridge the time gap between planning and full scale plan implementation*" (Shrestha & Apedaile, 1980), some public capital projects were started before the formal agreement between Nepal and Canada was signed.

It was planned to implement the K-BIRD plan in seven districts the sixth (1980-1985) plan and in the remaining three districts in the seventh plan (1985-1990) of Nepal. However, during the sixth plan, IRD was implemented in only three hill districts.

"*Integrated rural development is a process which pursues several development initiatives simultaneously*" (Apedaile, 1980). The objectives of the K-BIRD program were multidimensional. The main objectives were:[2](K-BIRD, 1980a and KBIRD, 1980b Annex 2)

1. Change from a subsistence economic society to a growth oriented society.
2. Increase the productivities of the factors of agricultural production.
3. Increase the income multiplier effect of public spending.
4. Increase output in the agriculture and livestock sectors.

[2] The objectives are summarized from K-BIRD, 1980a and KBIRD, 1980b Annex 2.

5. Increase forest resources and generate hydroelectricity.
6. Increase the availability of basic public goods and services.

To achieve the objectives, the strategies were:[3](K-BIRD, 1980a and 1980b Annex 2)

1. Increase the level of household effort in agricultural production with public investment in directly beneficial irrigation, transportation, technology and credit.
2. Create a development oriented and efficient administration at the village and district levels of government.
3. Generate local revenue to support recurrent costs of local development programs.

Surkhet District: Surkhet is one of the five districts of Bheri Zone. The headquarters of this district, Birendranager, also serves as the headquarters of the mid-western development region. The total area of this district is 249,000 ha. The total population in 1981 was estimated to be 165,666 persons (Department of Agricultural Marketing Services/HMG, 1983). Ninety six percent of the population had agriculture as their occupation (United Mission to Nepal, 1985). For political and administrative purposes, Surkhet is divided into fifty village and one town panchayats. Surkhet is in the hilly region of Nepal. Three land systems, namely the Siwalik Range (or Churia Hills), Mahabharat Range (Middle Mountain Range) and Duns and Valleys are found in this district. The altitude ranges from 250 meters to 2200 meters above sea level. Mainly due to the variation in altitude, four types of climates are found in this district. Between 1971 to 1981, the recorded average minimum and maximum temperatures were 4.5^0 celsius in the month of January and 34.3^0 celsius in the month of May respectively. The average temperatures in the months of January and May are 11.9^0 and 27.5^0 celsius respectively. The recorded average rainfall in this district is 1526 mm, of which 87% falls between May and September. The minimum (10 mm) and the maximum (427 mm) rain falls in the month of November and July respectively (Department of Hydrology & Meterology, 1985)[4] The warm temperature and the pattern of rainfall are the two determining factors of the cropping system, cropping pattern and cropping intensity of this district. The main crop (or summer crop) depends upon the monsoon whereas the winter crop depends

[3] The strategies are summarized from K-BIRD, 1980a and 1980b Annex 2.
[4] Cited in Thai, (1985).

upon the local precipitation in the month of February. Due to the monsoon and the local precipitation in the month of February, almost all lands are cultivated twice a year. The cropping intensity in this district was found to be 186 (Survey result)[5].

The total cultivated land in this district is 35,863 ha., of which 4% is irrigated, 15% is partially irrigated and the remaining 81% is rainfed (Thai, 1985). However, 33% of the cultivated land is used to grow rice. The average size of land holding per farm family is 1.5 ha. and the average size of a farm family is 6.16 (Thai, 1985).

Mixed farming is a common practice in this district. Livestock are an essential component in the farming system. Livestock are complementary as well as supplementary to the agricultural system. In this district almost every farm family tries to produce every thing they need in their daily life. It is self sufficiency and not profit motive which determines farming decisions. For this reason, farmers produce numerous farm products year round.

A motorable road linking Birendranagar with the East-West Highway is under construction[6]. After the completion of this road the eastern part of Surkhet District will have a motorable access to almost all the commercial towns of Southern Nepal and Northern India. At present this road may be used only from October to May, but landslides can block the road any time of the year.

The geophysical and economic conditions of Surkhet District qualify this district as one of the least developed districts of Nepal. Public capital facilities, before and after the implementation of IRD program, have been spread unevenly over the panchayats of the district. For these two reasons, Surkhet was considered to be an appropriate place to test Hirschman's *development via excess capacity* model.

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[5]The previous studies have also found similar value of cropping intensity. For example see Apedaile, (1980); Thai, (1985); United Misson to Nepal, (1985).
[6]East-West Highway is in the tarai region of Nepal, which crosses from the east to west border of Nepal.

Table 1.1 Public Capital Situation in the Village Panchayats of Surkhet District of Nepal: Before the Implementation of the IRDP and at the End of the Fiscal Year 1985/86.

Public Capital.	1978*	1985/86**
Banks.	0	6[1]
Personnel working in Agriculture related office.	44[2]	169
Schools:[3]		
Primary.	119	162
Middle.	15	37
High.	3	9
Ag. Service Centers.	0	6
Livestock Centers.	0	6
Ag. Input Corporation.	0	1
Motorable Road.	0	10 miles[4]
Soil Conservation Program.	n/a	9
Drinking Water Project.	n/a	32
Publically Developed Market.	n/a	3
Women's Training & Development Centers.	1	1

Sources: *"Hand Book of Statistics", K-BIRD, Kathmandu, Nepal 1978.
** Sample Survey Data.

[1] Small farmers program is counted as Bank.
[2] Includes personnel working in Birendranagar.
[3] Schools in Birendranagar are included.
[4] Surkhet, Nepalgunj road is not included.
n/a Not available.

II. Research Methodology

A. Introduction

A comparative analysis was designed to achieve the objectives of this study. Surkhet District in the hilly region of midwestern Nepal was selected for the study. Two sets of three panchayats were selected. One set is in the west half of the district with relatively less public capital and the other set is in the east half with a relatively high amount of public capital. Both sets of three panchayats exhibited similar geophysical conditions.

The panchayats with a higher amount of public capital were defined as developed, while the panchayats with lower amount of public capital were defined as less developed regions. In the developed and less developed regions private capital formation and agricultural production on family farms was estimated. Finally the contribution of public expenditure to private capital formation and to agricultural production was estimated to determine the total social return of public expenditure in public capital.

The aggregate production function approach (developed by Zvi Griliches) which measures sources of growth was used to estimate the contribution of public capital and level of development to private capital formation and agricultural production (Griliches, 1964). Ordinary Least Squares was used to estimate the behavioral and technical relationship of private capital formation and agricultural production.

The information collected to perform the analysis included:

1. Geophysical information of the district.
2. Physical existence of public capital.
3. Monetary value of public capital.
4. Expenditure by government on public capital.
5. Farm families' present level of private capital formation.
6. Factors influencing private capital formation of the farm families.
7. Information on agricultural production and the factors of production.

B. Selection of the District

The main reason for selecting Surkhet District was the availability of information on its natural endowment. Surkhet is within an area subject to the integrated rural development project known as K-BIRD financed by Canada.

C. Selection of the Panchayats in Surkhet District

The panchayats were ranked according to the physical existence of public capital facilities. The extreme cases of the three highest and the three lowest ranked panchayats, with some substitutions explained below, were selected. All types of public capital were given equal weight regardless of the difference in the service, size, importance and monetary value. A panchayat was given one mark for the existence of any one of the forms of public capital listed in Appendix III. The total score of a panchayat was determined by the total number of distinct public facilities. The panchayats were ranked in descending order according to the number of public capital facilities. The panchayats having an equal number of capital facilities were given equal ranking (Appendix V).

Four types of climate are found in Surkhet District, namely subtropical subhumid, subtropical humid, warm temperate humid, and cool temperate perhumid. For simplicity, the panchayats were divided into four groups according to the dominant climate within their boundaries (Appendix V).

The number of panchayats was not sufficient in the cool temperate perhumid and subtropical humid dominated climatic region. Consequently these mountainous climatic regions were not considered. The number of panchayats in the warm temperate humid and subtropical subhumid produced an adequate base for the analysis. From among the subtropical subhumid and warm temperate humid climatic regions, the subtropical subhumid climatic region was selected. It was selected because this climatic region offered a sufficient number of panchayats, poor in public capital as well as rich in public capital. Whereas in the warm temperate humid climatic region there was only one panchayat, Jarbutta, whose ranking was above average (The median of the rank was 8.5 capital facilities).

In the subtropical subhumid climatic region, the panchayats situated on the bank of Bheri River are almost homogeneous in terms of their drainage systems. As a result, these panchayats were chosen for this study.

In the subtropical subhumid climatic region and Bheri drainage system, the altitude covered was seven hundred to one thousend meters from the sea level. There are three main areas in terms of types of cultivation in this region, namely predominant Khet (irrigated land) area, predominant Pakho (unirrigated land) area and Khet and Pakho (mixed) area. Most of the farmers in this area were found to be holding mixed land. Farmers holding mixed land were selected for the study.

In the subtropical subhumid climatic region light, medium and densely cultivated areas are found. These densely cultivated areas were chosen as the study area [7]. In this climatic region, there are numerous types of soil zones. The area having Aluvium soil mainly of river deposit was selected to study.

As mentioned earlier, it was planned to select two sets of three panchayats, one set having a large amount of public capital and the other a small amount of public capital. At this stage in the selection procedure, the services enjoyed by the farmers were also considered, since the public services enjoyed by the farmers are considered important in their capital formation decisions. The flows of services in each of seven high and low ranked panchayats were studied. The flow of services between panchayats (Appendix VI) revealed that the farmers in the highest ranking panchayats, Dasrathpur, Ramghat, and Sahare enjoyed significant levels of public services originating outside their panchayats. Contrary to the primary ranking scheme, Dahachaur and Lekhpharsa were not deprived of public services, but rather enjoyed considerable public services from their neighbouring panchayats. The most deprived panchayats in terms of public services were Ghatgaun, Pokharikanda, Tatapani and Taranga. This deprivation was evident in terms of the amount of public capital as well as the flow of services from the neighbouring panchayats.

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[7] Apedaile, (1978) & Thai, *et. al.*, (1985) show that the cropping intensity in Surkhet District is close to 200. So, it was felt that the densely cultivated area is the real representation of the situation.

The decision in selecting between Tatapani and Taranga was primarily an administrative one. Since both panchayats are similar in almost every respect, Tatapani was chosen because of its accessibility[1]. In the final analysis, the panchayats selected for study included Tatapani, Ghatgaun and Pokharikanda as the less developed Panchayats; and Ramghat, Dasrathpur and Sahare as the developed Panchayats.

D. Definition and Measurement of the Variables

This section concerns the definition and the measurement of the variables used in this study.

Definition and Measurement of Private Capital

Definition of Private Capital

Thirwall (1978) suggests that capital is a wide concept and one which requires further clarification. Usually capital is defined as a factor of production. In this study, to develop a testable hypothesis and to use the production function approach to test the hypothesis, capital was defined as durable factors of production created from savings or retained earnings. However, capital can take tangible as well as intangible forms. For simplicity, only tangible capital was included in this study. That is to say, the narrow definition of capital was applied in this study (Thirwall, 1978; Radwan, 1974). Capital was distinguished from consumption goods realising that the capital yields no present utility but helps to produce future measurable income (Kuznets, 1955). The repair and maintenance cost of capital was not included due to the inevitable problems of separating expenditure between capital improvement and recurrent costs. Theoretically, that part of repair and maintenance cost which increases the life and productive capacity of the capital is included in capital, whereas the expenses made in maintaining the working condition of capital is included in recurring cost. To separate repair and maintenance cost is difficult because it involves arbitary value judgement. Therefore it was decided not to

[1] Two days of survey work were saved by this decision.

include these expenditures in capital. Keeping these factors in mind, private capital of the farm family was defined as tangible productive assets, other than land, having life of more than one year and which help to increase future agriculture production.

Measurement of Private Capital

Private capital of a farm family was separated into two categories depending on the timing of its possesion. Private capital accumulated before 1982 was termed as capital stock whereas capital accumulated from 1982 to 1986 was termed as capital formation. As capital formation and capital stock include the same durable goods, the definition and the procedure used to measure capital formation is valid for capital stock. For simplicity the common word capital will be used to explain the measurement procedure.

Capital formation and capital stock are physically the same thing, but economically they are different. Capital stock, a static measure of capital, is mainly determined by the size of land holding. Capital stock and size of land holdings are positively correlated. Capital formation is the dynamic counterpart of capital stock and is determined by many other factors including the growth rate of public capital. The increase in the public capital, by increasing agricultural production and technological level, stimulates farm families to accumulate private capital. To determine the contribution of the growth of public capital and the level of development to the growth of private capital, private capital was separated into (a) private capital formation and (b) private capital stock.

Approach Used to Measure Private Capital

The four ways of measuring capital are: (a) the commodity flow approach (b) the expenditure approach (c) accounting for the changes in physical stock of capital approach and (d) aggregate saving approach. Accounting for the changes in physical stock of capital is considered a better approach in comparison to the other approaches, but requires information on changes in the stock of raw materials, finished and semi-finished goods, which are very difficult to obtain (Tiwari, 1971). So, the expenditure approach was applied to measure capital. The quantities of all capital goods

were measured by summing the money payment made by a farm family to acquire the capital goods. The labour devoted to build capital goods was not included, assuming a zero opportunity cost of labour.

Adjustment for the Changes in Price

The value of capital goods was estimated at current prices. For analytical purposes the values of capital goods were converted into constant prices based on 1986. In the absence of a rural consumer price index, the urban consumer price index of Nepal was the deflator used in this study. Due to the lack of an urban consumer price index before 1964, capital values created before 1964 were deflated using the 1964 price index.

Accounting For Depreciation

Capital, by definition, is a long lasting tangible asset which is used in the production process. In the course of time, capital loses its value. So the proper measure of capital is the present value of capital, which is different from its acquisition value. The difference is known as depreciation. Depreciation is defined as: the amount which is charged against the production of the year to allow for the fact that equipment originally charged to capital account has become older, more worn and perhaps more obsolete during the year (Feinstein, 1965). Similarly the UN. (1953) defines depreciation as " *The decrease in value at current prices of durable physical assets. Alternatively, it is often taken to represent the present cost of replacing the current loss in the economic worth from wear and tear and obsolescence of physical capital.*" However " *it is a process of allocation not of valuation. Depreciation for the year is the portion of the total charge under such a system that is allocated to the year*" (Radwan, 1974).

There are several methods of depreciating capital. All the methods are arbitrary in the sense that no single method has been generally accepted by economists. However the most widely used methods are straight line and reducing balance. The reducing balance method was used for the following reasons:

1. This method treats capital as having a certain positive value until it is completly discarded, which seems reasonable especially in a developing country like Nepal.

2. In this approach the value of capital is depreciated in a decreasing trend. That is, the value of capital is depreciated in progressively smaller amounts in successive years.
3. This method, contrary to the straight line method, avoids the sudden change at the end of the assumed life of the capital from a constant depreciation to no depreciation at all.

For computational purposes Doll and Orazem's (1984) formula, presented below, was adopted for this study.

P = Purchase Price of Capital.

k = Rate of Depreciation of the Capital.

n = Number of Years of Possesion of Capital.

D = Depreciated Value of Capital.

$$D = Pk^n$$

Composition of Private Capital

Private capital in this study is composed of, (1) home and home extensions, (2) animals, (3) agricultural tools, (4) construction and addition of the irrigation facility developed by a farm family, (5) cow-shed, (6) orchards, (7) land development, (8) fences and (9) drinking water facilities developed by a farm family.

As the capital goods are of a heterogeneous character, the rates of depreciation and method used to estimate different types of capital goods were as follows:

Home and Home Extension: In general homes and home extensions are included in farm capital. Homes in the rural areas of Nepal in particular are used as barns, cowsheds, storage and for commodity processing as well as for basic housing of farm labour. The total money spent by a farm family to build and extend the house was defined as capital. The rate of depreciation used to convert gross value of home and home extension capital to net value of home and home extension was two percent.

Animal: Usually anything that has a natural growth rate is not included in capital. In this study it was decided to include cattle, horses, and mules because they function as capital. These functions include manure, draught power and transport.

The money spent by a farm family to buy animals in between 1982 to 1986 was defined as capital formation. Goats and poultry were not included as capital. The home born animals were not included in capital and the monies spent on animals were not depreciated. Animals purchased prior to 1982 were considered to be infertile and or too old to be productive. These measures were taken to not over or under estimate the monetary value of animal capital. As the animals purchased prior to 1982 were considered unproductive, there was no capital stock in the form of animals.

Orchard: Monies spent by a farm family to plant orchards were defined as capital formation. Orchard plantation constitutes land development which is included within the definition of capital. Similarly to animals, money spent to plant orchards prior to 1982 was not counted. Considering the natural growth of plants, the money spent to plant orchards was not depreciated. The money spent to plant orchards prior to 1982 was not counted, so there was no capital stock in the form of orchards.

Agricultural Tools: Money spent by a farm family to buy agriculture tools was defined as capital. Agricultural tools are made and repaired by a blacksmith, to whom farm families pay a certain retainer on an annual basis. The payment is usually made in "kind". In this study "kind" was converted into money. One third of the payment made to the blacksmith was included with other expenditure on tools. Ten percent was the rate used to depreciate the gross value of agricultural tools.

Drainage: Money spent by a farm family to improve land drainage was defined as capital. The rate used to depreciate the gross value of drainage was twenty percent, in recognition of the use of wood and the rate of siltation associated with the extensive soil erosion in the Sewalik and Mahabharat hills.

Threshing Floor: Money spent by a farm family to construct a threshing floor was defined as capital. The gross value of a threshing floor was depreciated at the rate of two percent.

Cow-shed: Money spent by a farm family to build a cow-shed was defined as capital. The rate used to depreciate the gross value of a cow-shed was ten percent.

Land Development: Money spent by a farm family to develop their land was defined as

capital. Mainly money spent by the farm families to level, to terrace and to contour the land were included in this category of capital. Six percent was used to depreciate the gross money spent in land development.

Fences: Money spent by a farm family to construct fences was defined as capital. Two rates, five and twenty were used to depreciate the gross value of fences. The gross value of fences made from stone was depreciated at the rate of five percent and the gross value of fences made from wood was depreciated at the rate of twenty percent.

Drinking Water Facility: Money spent by a farm family to construct any type of drinking water facility was defined as capital. The rate of depreciation used to depreciate the gross value of drinking water facilities was ten percent.

Definition and Measurement of Public Capital

Definition of Public Capital: Social and economic goods and services, created partially or fully by the government, functioning as intermediate goods in agricultural production and capital formation of the farm families which, can be used by all farm families without any restriction were defined as public capital.

The use of public capital is not restricted to anyone. However in practice, public capital is used only by people farming in the vicinity of the public services. Thus the opportunity cost of public capital to provide services to an additional farm family in a certain region is zero, whereas it is positive between the regions (Boadway, 1973). That is, public capital has a positive cost attached to it. Whether the cost of public capital is higher than its benefit in a region may be determined by calculating its social rate of return.

Composition of Public Capital: Items listed in Appendix IV were considered as public capital in this study. Out of that list only certain types of public capital were in existence in each of the six different panchayats. The composition of public capital was different for each selected panchayat. The number of public capital in the panchayats is reported in Appendix V.

Measurement of Public Capital: The value of public capital was in current prices. The current value of public capital was converted into a constant value at 1986 prices. The urban consumer price index was the deflator used to convert the current value of public capital into

a constant value based on 1986. The value of public capital was depreciated at the rate of five percent using the reducing balance method of depreciation.

Definition and Measurement of the Other Variables

This section concerns the definition of other variables used in this study. They include:

Farm Family: Farm Family was defined as a group of people sharing the same kitchen regardless of any relationship (Table 2.1). [9]

Land: Land was defined as the total area of private land cultivated by a farm family, regardless of its ownership and quality (Table 2.1).

Literacy: The head of the farm family was considered as literate if he or she could read and write Nepali (Table 2.1).

Total Value of Agricultural Product: The monetary value of total agricultural product at 1986 prices was defined as total value of agricultural product. The prices of the agricultural products were the local prices in the month of Nov./Dec. 1986, collected by the author (Table 2.1).

Caste: Brahaman, Chhetris, Baisaya and Sudra are the main castes in the hierarcy of Nepal. Traditionally Brahaman and Chhetris are the most influential and wealthy people in Nepal, and they are much more concerned with their economic well-being (Bista, 1976; Hildreth, 1986). In this study the farm families were divided into two groups according to their caste. The farmers belonging to Brahaman and Chhetris caste were defined as upper caste farmers and the rest were termed as other caste farmers (Table 2.1).

Cropping Intensity: Cropping Intensity was defined using Joosten's definition of Intensity of Rotation(R) of cultivation [10]. So, cropping intensity for this study is equivalent to the number of years of cultivation (which was always one in this study) multiplied by 100 and divided by the length of the cycle of land utilization (which was one or less than one

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[9] The data were collected on a per farm family basis, so all the data are in per farm family basis unless stated otherwise.

[10] Adapted from Ruthenberg,(1976).

Table 2.1 Observed Mean Value of the Variables in Six Panchayats of Surkhet District of Nepal, 1986.

Variables.	Unit.	Tatapani.	Ghatgaun.	Pokharikanda.	Ramghat.	Dasrathpur.	Sahare.
Family Size.	Persons.	6.92	7.75	6.36	4.60	5.23	6.75
Land Holdings.	Ropani.	22.00	22.99	25.74	16.50	21.22	18.07
Literacy*.	Persons.	6/12	8/12	10/11	11/12	11/12	9/12
Value of Ag. Product.	Rupees.	12953	9848	12422	11540	17577	12189
Upper Caste*.	Persons.	7/12	6/12	7/11	11/12	11/12	10/12
Cropping Intensity.		182	192	164	182	205	186
Savings.	Rupees.	17975	20685	26872	17734	14863	22241
Value of Capital Formation.**	Rupees.	6027	5545	6036	6619	4895	8670
Value of Capital stock.**	Rupees.	1267	1232	3980	4606	7634	10464
Value of Public** Capital (1986).	Rupees.	847281	316945	680367	3231748	3417276	1758549
Government Expenditure.***	Rupees.	278619	102507	127967	1041207	786369	497312
Population (1986)	Persons.	3955	2723	2154	4762	2960	6128
Households.	Number.	572	351	339	1035	566	908
Govt. Exp.*** Per Household.	Rupees.	487	292	377	1006	1389	548

Sources: 1. Survey Results. * Shows the Ratio. ** Depreciated value. *** Expenditure in 1986.
2. Various Government Office of Nepal.

depending upon how many times and how much land a farmer cultivated in the calendar year 1985/86). Most of the farmers in the study area practiced intercropping, but intercropping was not considered in this study, as " *it is hard to use this formula for intercropping system*" (Ruthenberg, 1976, p. 16).

Saving Ability: Savings of farm families were expected to reflect farm families' ability to accumulate capital. In the absence of banking facilities and few alternative investment opportunities, it was assumed that the farm families store their savings either in consumer durables, mainly in the form of precious metal or in the form of land rights. So, savings in this study was proxied by the monetary value of consumer durables purchased and the money spent to buy land rights from 1982 to 1986. Durables included ornaments and utensils. Money spent to educate childern in the calendar year 1985/86 was also included.

E. Data Collection

Sources of the Data

Primary as well as secondary sources were used for data. Secondary sources were used for information on the geophysical condition of the panchayats, public capital, public expenditure and the size of land holdings. The source of the rest of the data is a sample survey conducted by the author.

Collection of the Secondary Data

The geophysical condition and the political and administrative boundries of the panchayats were analysed with the help of the maps published by the Topographical Survey Branch of HMG of Nepal and maps published in various publications of Kenting Earth Science Limited, Kathmandu, Nepal. The Local Development Officer's office provided the information on the physical existence and the value of public capital in all the panchayats of the Surkhet District of Nepal. The operation and maintenance cost of public capital facilities were collected from various government offices of HMG located in the Surkhet District of Nepal. Information on the contribution of the people in the formation of public capital and

the extent of the services provided by the public capital were gathered from the local leaders and knowledgeable persons. The size of land holdings of farm families were collected from the record book of the Land Tax Office of the Surkhet District of Nepal.

Method Used to Collect Primary Data

The primary data was collected using personal interviews of a random sample of farm families. Collection of the data began on February 3, 1987. It took one month to complete seventy one interviews. All interviews were done by the author.

In this study farm families having only 0.35 ha. to 2.1 ha. of land holdings were sampled. The study was confined to this specific group of farmers, because of the controversy of the size neutrality of new technology introduced in developing countries. On the one hand, Hayami (1981), Hayami & Ruttan (1985) and the advocates of the green revolution have argued the size neutrality of new technology introduced in developing countries. On the other hand, the critics of the green revolution argue that new technology introduced in developing countries is biased towards big farmers (Wharton, 1969; Johnston, & Cownie, 1969; Falcon, 1970). So the data collected from farm families having 0.35 ha. to 2.1 ha. of land holdings was expected to avoid size non-neutral distributional effects of public capital on private capital formation and agricultural production.

The farmers interviewed were selected from a list of all the farmers within the size range and known to farm in the panchayat. The specific respondents were selected by lottery drawing. The list of the farmers was prepared with the help of the land tax office's record book of land holdings. In total, eighteen respondents from each panchayat were chosen by using the non-replacement method of random sampling. Out of the eighteen respondents in each panchayat, the first twelve were the main candidates selected for interview, while the other six were chosen only for replacement purposes. In all the panchayats except Tatapani at least one alternative respondent was interviewed. The alternative candidates were used, when one of the first twelve candidates was not home or these candidates were not eager to provide information.

The questionnaire was composed of nine sections. Included in these sections were questions addressing biographic information, private capital formation, agricultural production, adoptation of modern technology, investment in consumer durables and valuable metals, the use of public capital, attitudes towards public services, a farm family's contribution to the formation of public capital, and sales income from farm products as well as monetary income from other sources.

The questionnaire is in Appendix X. In the month of Nov. 1986, a 25 day long visit was made in various panchayats to pretest the questionnaire and to determine the flow of services from public capital among the panchayats. The pretest of the questionnaire mainly showed that the farmers would not or could not report their sales and savings records over five years. As a result, the information on sales income was collected only for the year 1985/86.

The original intention was to scale the services provided by the government into five categories by the level of satisfaction provided. However pretesting revealed that a change in scale would be necessary, because people had no idea how to scale the services. The scale was reduced to three categories including: satisfied, not satisfied and do not know.

The pretest of the questionnaire also pinpointed specific problems in the question format. The detail of the question about the use of fertilizer was reduced because people were confused by the question. It was found that the use of inputs in agricultural production, like the use of pairs of oxen and labour, had to be asked on an individual crop basis. The list of the agricultural tools in the questionnaire was also changed, because some of the tools used by the farmers were initially excluded from the questionnaire and other tools included were not in use!

The questionnaire proved lengthy, as on average it took two and a half to three hours to complete a single questionnaire. Even though the questionnaire was in Nepali, the farmers often had difficulties understanding some of the questions. Consequently many questions required further clarification. Possible distortions arising in the clarifications were minimised because all interviews were carried out by the author. Most of the farmers were eager to know about the interviewer and why the information on their sickel, hoe, load carrying rope,

husking machine, mat and other things was needed. Basically the farmers were not prepared to answer these questions, so it took longer than expected. It was especially time consuming to collect information on agricultural tools. Questions such as the number of tools, the price of tools, time of possession of tools, and durability of the tools turned out to be the most complicated questions. Approximately fifty percent of the time was consumed by this particular section.

F. Pooling of the Data, Estimation Procedure and Test Statistics

Pooling of the Data

In this study the data were collected in six different panchayats. The panchayats represented the developed and less developed regions. To perform the quantitative analysis, comparing the regions, the panchayat data had to be pooled for each region. But data can be pooled if and only if the data belongs to the same population. To test whether the data belongs to the same population or not, the Kolmogorov-Smirnov (K-S) two sample test was applied.

The K-S two sample test is an omnibus test because it is sensitive to all types of differences (*viz* difference in central tendancy, dispersion, skewness, kurtosis) in the data (Siegel, 1956 ; Daniel, 1978). The K-S two sample test examines the similarity between the cumulative frequency distributions of the data. The reasoning behind this test is that if the two samples are drawn from similar populations (or from similar distributions), their cumulative frequency distributions should be similar. If the cumulative frequency distributions of the samples are too far apart at any point, except for random deviation, this suggests that the samples are not from the same population distribution.

The K-S test was selected, because the K-S test is powerful in comparison to the X^2-test, Median test and the Mann-Whitney test for small samples (Siegel, 1956).

The K-S test may be applied to small as well as to large samples. The small sample test is applicable when the number of observations in both of the samples are equal and are less than 40. In our study, the sample size in the developed and less developed regions were 36

and 35 respectively. In this study, dropping one observation from developed region, the small sample test was applied to test the similarity of the data. The procedures used to apply K-S small sample test will be outlined in brief.

K-S Small Sample Test: The following steps were taken to apply the test.

1. The two set of samples, that were going to be compared, were tabulated using the same class interval.
2. The cumulative frequency distribution table was made for each sample.
3. The difference between the cumulative frequency distribution of each sample in each class interval was taken.
4. The maximum difference between the cumulative frequency distribution of the two samples was located. This was the observed difference between the samples.
5. A one tail as well as two tail test may be applied. However in this study the two tail test was applied, because we did not have any idea about the direction of the difference in the data, as explained below. In the two tail test, the absolute difference between the cumulative frequency distribution of the samples is campared with the critical value, to test the similarity of the samples.

   Symbolically:

   S_{n1} = Cumulative frequency distribution of the 1st sample.

   S_{n2} = Cumulative frequency distribution of the 2nd sample.

   D = Maximum observed difference, i.e.

   $D = | S_{n1} - S_{n2} |$

   C = Critical Difference, produced by Siegal (1956) was used to make decision.
6. One percent was the level of significance chosen in this study.
7. The maximum observed difference is compared with the critical value.
8. Decision Rule: If the maximum observed difference was less than the critical difference, the samples are similar (i.e. samples are considered coming from the similar population) and vice versa.

A mean test also was applied to determine the existence of differences of the variables in terms of their mean values. The test statistics were applied to test the mean value of the

variables between the panchayats within the regions and between the regions. To compare the mean value of the variables between panchayats within the region, the small sample mean test was used and the large sample mean test was used to compare the mean value of the variables between the regions[11].

The results of the K-S and Mean Test (table 2.2):

1. The results of the K-S tests suggest that the collected data, within as well as between the region, belong to the same population.
2. The results of the mean test suggest that the mean value of the variables within each region are equal, whereas between regions they are not.
3. Two things are clear from these results. The data from the three panchayats within each region come from the same population and have similar characteristics, so they may be pooled to perform further analysis. The data for both regions come from the same populations, but the means for all variables are different. Therefore a comparative study between the regions may be performed.

[11] Adopted from Mason, (1978. p. 305)

Table 2.2 Kolmogorov-Simirnov and Mean Test of the Variables to Pool the Data within the Surkhet District of Nepal 1986.

Variables	Panchayat or Region Compared	K-S-Test	T-Test
Number of Family Members	1 VC 2 VS 3	Similar	Similar
	4 VS 5 VS 6	Similar	Similar
	1,2,3 VS 4,5,6	Similar	Not Similar
Size of Land holdings	1 VS 2 VS 3	Similar	Similar
	4 VS 5 VS 6	Similar	Similar
	1,2,3 VS 4,5,6	Similar	Not Similar
Savings	1 VS 2 VS 3	Similar	Similar
	4 VS 5 VS 6	Similar	Similar
	1,2,3 VS 4,5,6	Similar	Not Similar
Recurring Cost	1 VS 2 VS 3	Similar	Similar
	4 VS 5 VS 6	Similar	Similar
	1,2,3 VS 4,5,6	Similar	Not Similar
Capital Formation	1 VS 2 VS 3	Similar	Similar
	4 VS 5 VS 6	Similar	Similar
	1,2,3 VS 4,5,6	Similar	Not Similar
Capital Stock	1 VS 2 VS 3	Similar	Similar
	4 VS 5 VS 6	Similar	Similar
	1,2,3 VS 4,5,6	Similar	Not Similar
Total value of Agriculture Product	1 VS 2 VS 3	Similar	Similar
	4 VS 5 VS 6	Similar	Similar
	1,2,3 VS 4,5,6	Similar	Not Similar
Labour used in Agriculture	1 VS 2 VS 3	Similar	Similar
	4 VS 5 VS 6	Similar	Similar
	1,2,3 VS 4,5,6	Similar	Not Similar
Cropping Intensity	1 VS 2 VS 3	Similar	Similar
	4 VS 5 VS 6	Similar	Similar
	1,2,3 VS 4,5,6	Similar	Not Similar

Source: Survey Results.
Significance Level = 1%

1 = Tatapani
2 = Ghatgaun
3 = Pokharikanda
4 = Romghat
5 = Dasrathpur
6 = Sahare

Estimation Procedure

In this study public capital was considered as the main source of agricultural growth and development. On the one hand public capital was considered to stimulate private capital formation of the farm families. On the other hand public capital was considered to increase agricultural production. Should this dual contribution of public capital in theory be supported by the evidence, public expenditure on public capital may be economically beneficial in terms of its rate of return. Private capital formation and agricultural production of the farm families in the developed and less developed regions of the Surkhet District of Nepal were compared to determine the contribution of public capital to private capital formation and to agricultural production. The social rate of return of public expenditure in public capital was calculated to determine the economic rationale of public expenditure in public capital.

The production function approach of finding the sources of growth primarily developed by Griliches was the technique used in this study. The unrestricted Cobb-Douglas production function is the usual functional form used to apply Griliches technique (Akino & Hayami, 1974). The Cobb-Douglas production function was selected for the following reasons:

1. In comparison to the linear, quadratic and semi-logarithmic functional form the logarithmic form of a Cobb-Douglas function had a better fit.
2. The estimated parameters are the elasticities of the dependent variables with respect to the independent variables, which are easy to interpret.
3. The return to scale of the production process can be determined by adding all the estimated parameters.
4. The required transformation of the data to logarithmic form preserves the normality of the data, which is a desirable character, to use regression analysis (Tintner, 1944).
5. The constant production elasticity of output implied in Cobb-Douglas functional form, while one of the drawbacks of this functional form, is not a critical limitation especially in the short to medium run analysis (Nelson, 1964).

The Cobb-Douglas production function used to estimate both private capital formation and agricultural production can be expressed as follows:

$$\text{Log } Y = A + \alpha_i \text{ Log } X_i + \ldots\ldots + \alpha_n \text{Log } X_n \ldots\ldots (1)$$

When used as the agricultural production function, Y is total value of agricultural output and X_i are factors of production, where i runs from 1 to n. A is a constant term and α_i are output elasticities, which have to be estimated.

In the private capital formation equation, Y represents the total value of private capital and X_i are the factors that determine the formation of private capital. A and α_i are the constant and the elasticities of private capital with respect to the corresponding independent variables.

Ordinary Least Square (OLS) was the technique used to determine the relationship between the dependent and independent variables. An intercept dummy variable was included in the regression equations to compare private capital formation and agricultural production of the farm families between the developed and the less developed region. Slope dummies were included to compare the contribution of the independent variable to the dependent variable between the developed and less developed regions.

Finally, in an effort to determine the marginal productivity of public capital the contributions of public expenditure to private capital formation and agricultural production were calculated. The method used to calculate marginal productivity is similar to Griliches (1964) method. The elasticities of private capital formation and agricultural production, with respect to value of public capital, were used to calculate the contributions. This was done assuming that public capital was created due solely to public expenditure. The contribution of public expenditure to private capital formation was inserted as a data point in the estimated agricultural production function. This measure was taken to find the contribution of public expenditure to agricultural production via private capital formation. As well, the contribution of public expenditure to agricultural production and the contribution of public expenditure to agricultural production via private capital formation were added to find the total contribution of public expenditure to agricultural production.

Test Statistics

The results derived from OLS technique are reliable and efficient if and only if the estimated regression equations fulfill the assumptions of the OLS. The main assumptions of OLS are:

1. The dependent variable bears a causal linear relationship with the independent variable.
2. The systematic variation of the dependent variable is explained by the fixed independent variable. Thus the independent variables by assumption have no probability distribution, whereas the dependent variable holds a normal distribution with respect to each independent variable.
3. The disturbance terms are independent of each other, i.e. lack of autocorrelation.
4. The variance of the disturbance terms are constant, i.e. no heteroscedasticity.
5. The independent variables are independent of each other, i.e. no multicollinearity.

The linear relationship between the dependent and all of the independent variables included in the regression equations was tested with the F-test. Five percent was chosen as the level of significance.

The dependent variables in this study were value of private capital formation and total value of agricultural production. The normality of both of these variables was tested using the Kolmogorov-Smirnov one sample test. The distributions of these variables were found to be normal (Appendix VIII).

In cross sectional data the problem of autocorrelation is very rare, but it can not be totally ruled out. The Durbin-Watson test was applied to test the problem of autocorrelation in the regression equation. The problem of autocorrelation was not detected in any of the estimated regression equations. The observed d-statistics were between 1.9 to 2.27.

Goldfield-Quandt test was used to test the problem of heteroscedasticity in the estimated regression equations. The test was applied to all the quantifiable variables. The problem of heteroscedasticity was not found with respect to any of the independent variables.

The independent variables in growth models can hardly be independent of each other, so in a strict sense multicollinearity is an unavoidable problem. However, the problem becomes serious when the estimated regression equation results in conflicting information, like

high R^2 along with low t-ratios of the independent variables, or significant F-values where all of the independent variables are insignificant. As there is no direct test of multicollinearity indirect methods were used. The correlation coefficients between the independent variables were estimated to test statistical significance of the association between the independent variables. The independent variables land and labour, and land and public capital in the agricultural production function were found to be significantly correlated (Z-test at 1%). Similarly, the independent variables public capital and capital stock, and savings and capital stock were significantly correlated (Z-test at 1%), in the private capital formation function (Appendix VII). Even though two sets of two variables in each regression equations were found significantly correlated to each other, the estimated regression equations did not provide conflicting test results. For this reason the estimated coefficients of the regression equations were considered to be efficent.

The significance of the unconventional variable, public capital, in private capital formation and agricultural production functions was tested using the F-test of the increase in R^2 due to the inclusion of public capital in the regression equations. In the estimated regression equations public capital was found to be a significant variable.

The dummy variable test was applied to compare the developed and less developed regions.

The explanatory power of the individual independent variables in the estimated regression equations was tested using the t-test.

III. Theoretical Discussion and Model Specification

A. Introduction

Capital accumulation has been viewed as both the cause and effect of economic growth and development. Accumulation of capital represents wealth and is an indication of economic development (Carnicross, 1962b). Capital formation is also a source of economic growth (Denison, 1980; Carnicross, 1975). Capital is formed and accumulated by both private interests and by societies. The process of capital formation has consequently been a matter of considerable study, especially since the industrial revolution. Theories and hypotheses on the subject have been extended beyond industrialised economies to form the basis for policies of agricultural and rural development of subsistence economies. The following review of literature is directed particularly at the hypotheses that formation of capital by society in the form of transportation, communication, education facilities, health, water and agricultural extension services stimulates private capital formation by farm families. The review produces a brief historical perspective and is confined to the relationship between public and private capital formation.

B. Historical Perspective of the Role of Capital in Economic Development

The role of capital in development has been analysed in three different ways. Economists analysing the role of capital in developed countries usually analyse it at the national level. In contrast, economists analysing the role of capital in developing countries normally analyse it at the sectoral level. A third group of economists have analysed the role of public capital in production. The Classicists, Marxists, and the Keynesians belong to the first group. The second group is comprised of Balanced-Growth theorists, Unbalanced-Growth theorists, Dual-Economy theorists, and Minimum Effort theorists. Economists like Pigou, Meade, Schultz, Griliches and Antle, to name a few , are in the third group.

Classicists, Marxists and Keynesians, while having different explanations, end up with similar conclusions as to the role of capital in economic development. They conclude that capital is the most important factor in economic development, but in the long run, capital will

cease to contribute to economic development. Ricardo argued that this was due to the law of diminishing returns in agriculture. Malthus predicted a similar result with his theory of population. However, Marx predicted that the economy depending upon the market mechanism was bound to collapse in the long run and capital would cease to contribute to development [12]. Keynesians, in believing that the marginal efficiency of capital will tend to zero, also predicted similar results. Long run sustained economic growth and development according to all of them was possible only with technological improvement. They also argued that capital accumulation is possible without technological improvement, but technological improvement is not possible without capital accumulation.

Lewis (1958, 1963) pointed out the existence of a dual economy in developing countries. Agriculture, a subsistance sector, and industry, a modern exchange sector, were viewed as two distinct sectors. In typical underdeveloped countries the agricultural sector is equipped with an unlimited supply of labour in the sense that the marginal productivity of labour is zero or even negative. Under these circumstances Lewis predicted that the capital generated in the industrial sector plays the main role in economic development. Ranis and Fei (1961) have explained the three stages of development in a dual economy and the role of capital in economic development. Ranis and Fei's first stage is similar to Lewis's view of the dual economy. In their second stage, Ranis and Fei suggested that the supply of labour to industry is not unlimited while their third stage focusses on the adverse terms of trade faced by the industrial sector. The adverse terms of trade, according to them, can be avoided only by investing in the agricultural sector. Jorgenson (1961) believed that only the agricultural sector would experience a positive marginal productivity of labour. Jorgenson ruled out the existence of zero and negative marginal productivity of labour in an agricultural sector primarily as a result of the outmigration of labour from agriculture to the industrial sector. Moreover he also advocated investment in the agricultural sector to avoid the adverse effect of outmigration of labour from the agricultural sector to the industrial sector.

The economic setting and the functioning of the economy were viewed differently by economists. All believed that outmigration of labour from the agricultural to the industrial

[12]Marx's view is valid only for a capitalistic system.

sector was essential to development and inevitable. Jorgenson, Ranis and Fei argued that in the absence of investment in the agricultural sector, outmigration of labour from the agricultural sector to the industrial sector would have a negative effect on agricultural production. The result would be a reduction of industrial growth as a result of its dependence on the agricultural surplus. These economists advocated investment in the agricultural sector for economic growth and development.

The balanced-growth theorists were in favour of simultaneous investment in all sectors of a country. Balanced growth theorists (mainly Rosenstein-Rodan and Nurkse) believed in creating adequate demand for the newly produced goods and services within the country. Scitovsky and Fleming also advocated the balanced-growth doctrine assuming "*that the relationship between industries is for the most part complementary, the limitation of factor supply ensures that that relationship is for the most part competitive*" (Fleming, 1963, p. 279). Lewis[13] was in favour of the balanced-growth doctrine to maintain equilibrium between the agricultural and industrial growth. Lewis recognised the interdependence between agriculture and industry in economic development and thus advocated investment in both sectors.

The unbalanced growth theorists arguing on practical and theoretical grounds, dispute the balanced growth doctrine. According to Singer "*... the resources required for carrying out the policy of balanced growth... are of such an order of magnitude that a country disposing of such resources would in fact not be underdeveloped.*" He concludes the theory is premature rather than wrong (Quoted by Higgins, 1959, p. 400). Hirschman (1960) thinks the balanced growth theory is theoretically wrong. He states "*My principal point is that the theory fails as a theory of development. Development presumably means the process of change of one type of economy into some other more advanced type*" (Hirschman, 1960, p. 51). Even though unbalanced growth theorists dispute the balanced growth doctrine, their solution also relies on investment; only the magnitude is different.

Nelson's (1956) "low-level equilibrium trap" and Leibestein's[14] "minimum effort thesis" rely on similar suppositions. According to them, a minimum percentage of the national

[13]Based upon Higgin's (1959) summary.
[14] Based on Higgin's, (1959) summary.

income has to be invested to realise a positive rate of economic growth.

While Pigou (1932) was the first economist to consider public goods as a factor of production, Meade (1952) formally showed the role of public goods in the production process. Meade defined public goods in two ways based upon their functions, *viz* "*atmosphere externalities*" and "*unpaid factors of production*". In his analysis atmosphere externalities are similar to factor augmenting public goods and the unpaid factor of production is similar to firm augmenting public goods (Manning & McMillan, 1982).

The modern economists have analysed public capital as a factor of production in the agricultural sector. These studies have taken public capital in the form of research and education as well as transport and communication. Schultz (1953), Griliches (1964), Peterson (1967) and Evenson (1967) are only a few economists who treated research and education as a factor of agricultural production. Antle (1983a, 1983b, 1982), Easter *et al* (1977) and Liang (1981) have included infrastructure in their agricultural production function as a factor of production. All these economists discuss the significance of public capital in economic development and advocated investment in public capital.

C. Sources of Private Capital Formation

The prerequisites of private capital formation by farmers are ability of the farmers, measured by savings, willingness of the farmers and availability of public capital to the farmers. In this study, accepting Schultz's (1964) view, the farmers are assumed to make investment decisions rationally. The rationality of the farmers signifies that the farmers' decisions to accumulate capital depend upon their savings and the availability of public capital. That is to say, the main source and stimulant of private capital formation are savings and public capital variables respectively. As such, investment theories related to these variables will be explained below.

D. The Relationship Between Public Capital Formation and Private Capital Formation

Hirschman's Model

Hirschman accepted the importance of public capital in economic development based on historical facts. He stated *"There can be no question whatever that SOC[15] investment is "essential" for economic development. The sizeable percentage of total investment occupied by SOC investment in all countries testifies to this fact"* (Hirschman, 1960, p. 86). Hirschman's main objective was to find an efficient and functional investment program. To accomplish his objective he analysed the relationship between private capital formation and public capital formation. He analysed this because he was fully aware that a country's development depends upon private capital formation. He states *"Investment in SOC is advocated not because of its direct effect on final output, but because it permits and in fact, invites DPA to come in"* (Hirschman, 1960, p. 84).

Hirschman distinguishes investment choices in two categories, postponement choices and substitution choices. In substitution choices, decisions are made to undertake one project over several options. In postponement choices, the sequence of the projects are decided. Hirschman was mainly interested on the postponement choices of investment. To him the decision making process involving the sequence of projects which should be undertaken was important. In his opinion, underdeveloped countries are not necessarily poor in resources, but rather they lack the means and ability to bring their resources into play. He argues, the decision to invest should be made in such a sequence that the economy maximises the benefits out of that sequence of investments.

Hirschman's model is based upon the following assumptions:

1. The relationship between SOC and DPA is not technically determined.
2. The cost of producing any given output of DPA will be the higher, the more inadequate the SOC of the economy.
3. Investment in SOC does not enter the DPA cost calculation.

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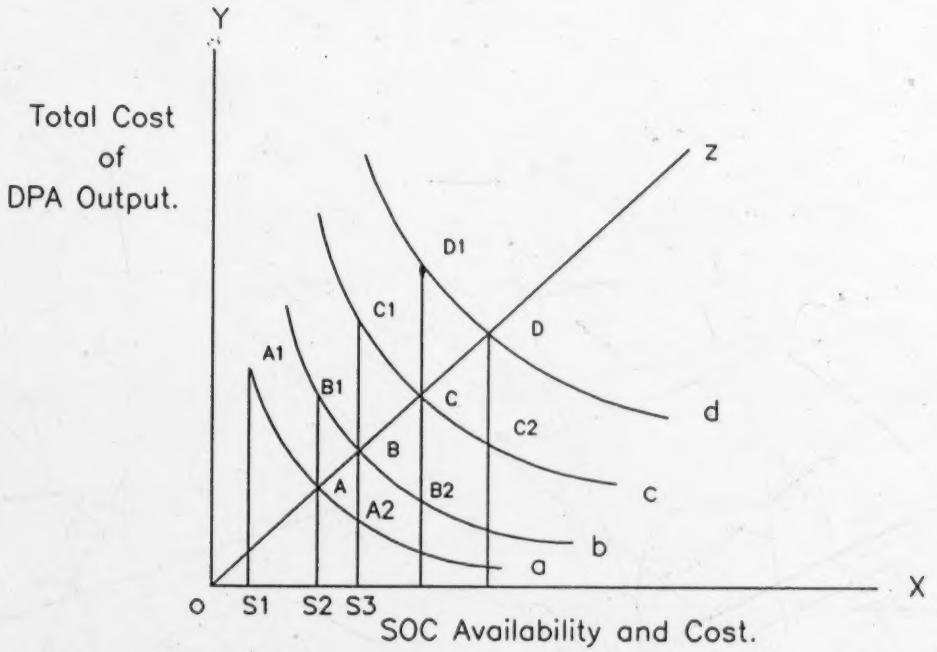
[15]Hirschman termed Public Capital as Social Overhead Capital (SOC) and Private Capital as Directly Productive Activities (DPA).

The functioning of the model will be explained adopting Hirschman's figure 3 in his book " *The Strategy of Economic Development*" (Hirschman, 1960, p. 87).

Figure 3.1: Hirschman's SOC and DPA Trade-Off



On the horizontal axis, availability and cost of SOC are measured, while the vertical axis measures the total cost of DPA output at full capacity. Hirschman is not clear on what *full capacity* is. However it seems reasonable to interpret full capacity in terms of private capital stock in plant and equipment. The a, b, c, and d are cost curves to produce different levels of *full-capacity* DPA output. The a, b, c, and d curves show the relationships between the private cost of producing different levels of DPA output according to the availability of SOC in the economy. The higher cost curve corresponds to a higher given level of investment in DPA enabling a higher level of DPA production. The a, b, c, d, curves are negatively sloped and convex to the origin, because the production cost of DPA is inversely related to the availability of SOC. OS_1 is the minimum amount of SOC needed as a prerequisite to stimulate producers to invest in DPA. Even though a, b, c, d, look like isoquants, in the strict

sense they cannot be considered as isoquants, because SOC is neither an input nor an internalized cost of DPA production.

The cost curves a, b, c, and d are drawn in such a way that the sum of the capital cost are minimum at the 45^0 line, OZ. So, the points on OZ represent the cost efficient points to produce DPA. *"The line (OZ)*[16] *expresses the ideal of balance growth of DPA and SOC: a bit of each at each step no doubt would result in the greatest economy of the country's resources"* (Hirschman, 1960, p. 87). So, the most efficient way to use resources to produce SOC and DPA is along the line OZ. But, developing countries cannot produce SOC and DPA simultaneously along this line, because they lack the ability to use resources so efficiently. Even in developed countries, SOC and DPA cannot be increased simultaneously. The practical solution for developing an economy is to adopt the postponement choice of investment where either investment in SOC or DPA is postponed. If an economy has "A" combination of SOC and DPA, and we assume an investment was made to produce OS_3 amount of SOC. The increase in SOC will stimulate the people to generate DPA because the production cost of DPA has gone down in the new economic environment. If this process is repeated, the growth path of the accumulation of DPA will be A A_2 B B_2 C C_2 D. This method of increasing the producing capacity of an economy is known as *development via excess capacity*. In the same manner, if investment in SOC is postponed in favour of DPA, the growth path of the accumulation of SOC will be A B_1 B C_1 C D_1 D. This method of increasing the productive capacity of an economy is known as *development via shortages*. As the final outcome of both investment choices is the same, Hirschman contends that the decision to invest in either of the two types of capital depends upon *"strength of enterpreneurial motivations on the one hand and on the response to public pressure of the authorities responsible for SOC on the other"* (Hirschman, 1960, p. 88). However in underdeveloped countries where little or no social overhead capital is in existence, only development via excess capacity is feasible. Hirschman states *"...the limits to such a policy are set by technological factors, since a minimum amount of SOC is a prerequisite at any given level of DPA. These limits may sometimes be rather narrow especially in largely underdeveloped regions and areas of new settlement where little or no*

[16]OZ is not in the text.

social overhead capital has as yet been created. Naturally, at this stage, only development via excess capacity is feasible" (Hirschman, 1960, p. 94).

The McMillan Model

McMillan (1979) also examined the role of public capital in an economy[17]. He argued that public capital increase production but via other factors of production. According to McMillan (1979), public capital are of two types: "*Goods which are public to factors and goods which are public to firms*". In the first case the total amount of public capital is available for use by any factor of production. Consequently altering the size of the firm does not alter the amount of public capital for the factors to work with. In the second case the total amount of public capital is available for the use of any firm in an industry, but firms use the same total quantity of public capital regardless of their size. Doubling the size of the firm halves the quantity of public capital per factor used by a firm.

The contributions of factor augmenting public capital and firm augmenting public capital are different in the production process. Factor augmenting public capital ultimately are Hicks-Neutral in the production process as a result of being shared equally by all factors of production without restriction. In contrast, firm augmenting factors of production become Hicks non neutral because they are shared only among firms, not among factors. Therefore, the implications for returns to scale are different for factor and for firm augmenting public capital.

Public capital contributes both directly and indirectly to the production process. Given this realization, McMillan proposes two types of production functions. For a factor augmenting public capital, his production function is as follows:

$$F(\lambda L, \lambda K; R) = \lambda F(L, K; R) \ldots\ldots\ldots(1)$$

Where, L & K are land and capital, R is factor augmenting public capital and λ is a parameter which measures return to scale.

The production function (1) takes the following functional form to satisfy the factor augmenting hypothesis.

[17]McMillan terms public capital as Public Intermediate Goods.

$$F(L, K, R) = F[A(R) L, B(R) K].....(2)$$

Where, A and B are parameters determined by the level of public capital. With constant returns to scale, F is linearly homogeneous in L and K.

The notable thing in equation (2) is that the contribution of the primary factors of production depend upon the level of public capital. This identification is important, because this study intends to estimate the contribution of public capital to agricultural production.

The firm augmenting production function of McMillan is similar to Henderson's (1974, p. 324) general production function, which is as follows:

$$Y = F (L, K, R).....(3)$$

Where: Y is output, L, K and R are labour, capital and public capital, respectively.
In Equation (3) public capital are included as a normal primary factor of production.

McMillan (1979, p. 97) in his concluding remarks argues "*It is difficult to think of a convincing example of firm-augmenting public intermediate goods.*" So, he claims his factor augmenting model makes better economic sense than the firm augmenting model.

The role of public capital in the production process is an unsettled question. Some economists (McMillan, (1979); Manning & McMillan, 1982) think that public capital augment factors of production. Others (Henderson, 1974; Tawada, 1982a & 1982b; Sandmo, 1972; Thompson, 1968) argue that public capital augment firms.

E. The Relationship Between Saving and Capital Formation

The capacity to accumulate capital depends upon the savings of the farmer (Hicks, 1960; Shukla, 1965). The savings of a farmer and his capacity to accumulate capital are positively related. In two different places with similar geophysical and socio-economic conditions the relationships between private capital formation and level of savings of the farmers may be expected to be similar. Conversely, under different geophysical and socio-economic conditions the relationship may be expected to differ. In this study, the two regions by design of the research are similar in every respect only their endowment of public capital and human behaviour in economic decision making were different. Under such circumstances the relationship between a farmer's capital formation and his level of savings in

the two regions provides important information. A stronger relationship between a farmer's capital formation and savings in the less developed region, vis-a-vis in the developed region will suggest the absence of a congenial relationship between private capital formation and public capital formation in the agriculture sector. Whereas the stronger relationship between a farmer's capital formation and his level of savings in the developed region, will indicate correspondance between private capital formation and public capital formation in the agriculture sector. Therefore exploring the relationship between farmers' private capital formation and his savings should provide an explanation of the role of public capital in the formation of private capital for the agriculture sector.

F. Empirical Situation

So far to my knowledge, the report prepared by ECAFE (1961) and Tara Shukla's (1968) paper are the only two studies which have estimated the relationship between the level of development and private capital formation, in the agricultural sector. [18]

The ECAFE (1961) paper was based on a comparative study to find the relationship between the level of development and of private capital formation. The study was done in Uttar Pradesh, India where three separate districts were selected. In each district a block area[19] and a non block area were selected to compare the level of private capital formation in the agricultural sectors. This paper found private capital formation in the block area to be higher in comparison to the non-block area. This result indicates a positive impact of the level of development on private capital formation.

Shukla (1968) also studied public and private investment in Indian agriculture. Her study covers three plan periods (1951-1966). Her study revealed a close correspondance between public investment and private investment. According to Shukla, an increase in private investment was due to private initiative and public support.

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[18] Liang (1981) and Antle (1983a) have estimated the relationship a little bit differently. The results of those papers will be reported later.

[19] Block area signifies the area where a community development program was in effect.

Nurkse (1954) and Cairncross (1962a) have also documented the historical statistics of capital formation in various countries. These papers provide historical documentation indicating that public capital has been the main factor in private capital formation.

Research and education is one part of public capital. Systematic work has been done by many economists using research and education as a factor of agricultural production. Considering these studies on research and education as an early development of the research work in the field of public capital, some of the landmark results are presented below.

Using the Index Number Approach, Schultz (1953) estimated the 1950 US agriculture inputs to produce the 1950 agriculture output and then estimated the inputs required to produce 1950 output with 1910 technique. In so doing he concluded that an additional 9.6 billion dollars worth of input would be required to produce the 1950 output using 1910 technology. Griliches (1964), Peterson (1967) and Evenson (1967) found research and education to be a significant variable in their agricultural production function. Griliches (1964) using his production function approach of finding the sources of growth analysed data collected from 39 US states. He discovered that approximately 13 dollars of additional output per year per farm resulted from each dollar of research and extension expenditure. Peterson (1967) using 1959 US cross-sectional data, found a return of $18.52 on 10 additional dollars spent on poultry research at the state experiment station. Evenson (1967) considered the lag effect of government expenditure in research and extension. Using Griliches's 1964 data, Evenson found a return of $10 on one additional dollar spent by the government in research and education.

Easter *et al* (1977) in their study based on Indian data, used hard surfaced road per square kilometer of cultivated land area as an infrastructure variable. They found the elasticity of agricultural output with respect to infrastructure, to be 0.133 and 0.218 for district and national levels, respectively. Antle (1983a) analysed data collected from 66 countries, 19 developed and 47 less developed countries[20]. He found the elasticity of agriculture output with respect to infrastructure, to be 0.248 for the total sample and 0.191

[20] He defined infrastructure to be the value of transport and communication services per square kilometer of land.

for 47 less developed countries. A correlation matrix estimated by Antle shows a positive correlation between infrastructure and use of the farm inputs by the farmers. Liang (1981) studied agricultural production in China. Liang included transport cost from farm to regional market as an independent variable in his production functuion. Transport cost is the only variable he used to estimate the effect of infrastructure on agricultural production. As expected, Liang found, on average, a 0.3% increase in farm output as a result of one percentage point decline in the cost of transportation. In this study, Liang also found correlation between transport cost and use of other inputs by the farmers. With the help of his results Liang concluded " *Improved transport conditions, and thus better accessibility, tended to raise prices to producers who may respond with a significant added input of resources in production for the market and significant increase in overall output*" (Liang, 1981, p. 83). Both Liang, (1981) and Antle's (1983a) results indicate that infrastructure can augment both factors and firms. That is to say, public capital can have both factor and firm augmenting characteristics.

G. Other Considerations

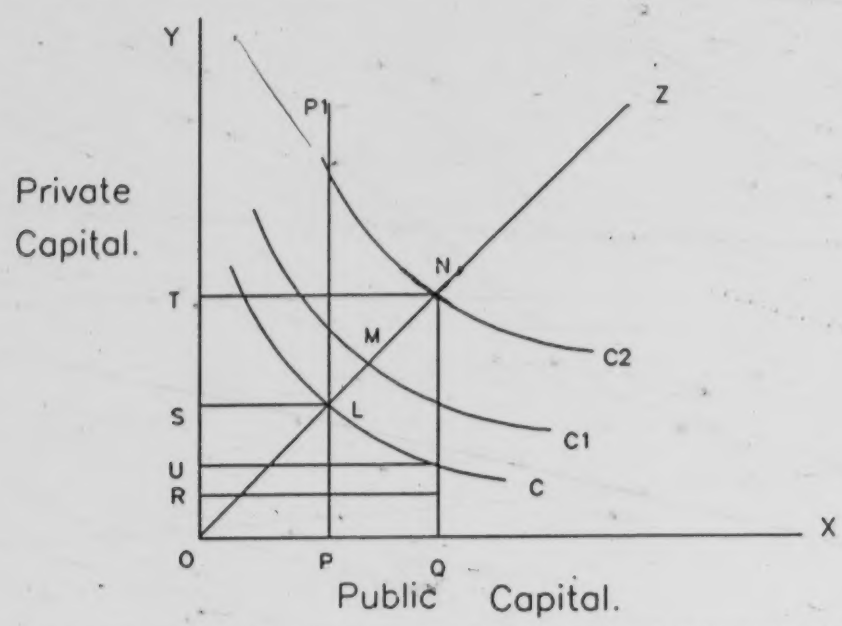
Other factors which have been considered in this study are capital stock, cropping intensity and caste. This section deals with literature surrounding these factors.

Capital Stock

Capital stock was one of the variables used to explain the variability of capital formation. The effects of capital stock on capital formation in general and in developed and less developed regions are explained with the help of a diagram. [21]

[21]Theoretically as well as empirically Chow (1957, 1960), Houthakker & Haladi (1960) and Houthakkar & Taylor (1970) have found an inverse relationship between the stock of consumer durables and the demand for consumer durables.

Fig. 3.2 Relationship Between Private Capital Formation, Private Capital Stock and Public Capital Formation.



Public and private capital are measured in the horizontal and vertical axis respectively. C, C_1, C_2, are isoquants of agricultural production where public and private capital are the two inputs. For simplicity, constant returns to scale is assumed in the production process. The producer is assumed to have sufficient ability to invest in private capital.

Suppose there is a price ratio such that when OP amount of public capital is available in the economy, the appropriate level of private capital of a farmer is OS for a given level of output C. Less than or more than OS amount of private capital will result increasing and decreasing returns to scale respectively, because with OP amount of public capital (fixed) the product expansion line will be along the line PP_1. With OP amount of public capital, a farmer will be in a better off position if he produces L amount of output using OS amount of private capital. So, with OP amount of public capital, OS is the appropriate amount of private capital to produce L amount of output. However in real life a farmer may have equal to, less than or more than OS amount of private capital. In a subsistence economy, with limited financial resources a farmer may have less than OS amount of capital because a farmer may prefer to

fulfill social commitments rather than accumulate capital. A farmer may accumulate more than OS amount of capital either because of ignorance or because of the precautionary motive of the farmer.

Now, let us assume public captal is increased from OP to OQ. In the new economic environment, the appropriate level of private capital is OT, because OT is the minimum amount of private capital which along with OQ amount of public capital can produce an economically beneficial amount of output N. However with the increase in public capital, a farmer can accumulate, maintain or reduce his level of private capital. If a farmer had OS amount of private capital, that farmer can produce output represented by the same isoquant C reducing his private capital to U. That farmer can produce higher output represented by the isoquant C_1 just maintaining OS amount of private capital. Now, if we assume that the farmer wants to produce economically beneficial amount of agricultural output (N), then he has to have OT amount of private capital. The farmer's accumulation of private capital depends upon his previous capital stock, because if that farmer had OS amount of private capital stock he will have to accumulate ST amount of private capital to produce the economically beneficial amount of output. If the farmer had OR amount of private capital stock, he will have to accumulate RT amount of private capital to produce the economically beneficial output. The diagram clearly shows the inverse relationship between demand for capital (private capital formation in this study) and private capital stock.

In the same diagram, let us say OP and OQ amount of public capital are available in the less developed and developed regions respectively. Let us assume a farmer has OR amount of private capital stock and wants to produce the economically beneficial amount of output. If the farmer is in the less developed region, he has to accumulate RS amount of private capital to produce the economically beneficial amount of output L. And if the farmer is in the developed region, he has to accumulate RT amount of private capital to produce the economically beneficial amount of output. With the help of the diagram we can say that the negative effect of private capital stock on the demand for private capital (private capital formation) depends upon the amount of public capital. The higher the amount of public capital the lower will be the effect of private capital stock on the demand for private capital

(private capital formation) and vice versa. That is, the negative effect of private capital stock on private capital formation should be smaller in the developed region in comparison to the less developed region. The theoretical argument seems reasonable because public capital may have positive externalities on factors of production including private capital. These externalities of public capital are tested in this study.

Public capital formation can have a positive, negative or neutral effect on private capital formation resulting in a negative, positive or neutral effect of private capital stock on private capital formation respectively. However, in this study the traditional subsistence farmers are assumed to produce an economically beneficial amount of agricultural output, so are considered to tend to accumulate the economically beneficial amount of private capital. Public capital formation will reduce the negative effect of private capital stock on private capital formation. Empirical verification of this relationship would lead support to Hirschman's theory of *development via excess capacity.*

Cropping Intensity

Cropping intensity, by definition, is determined by the number of times a crop is harvested from a given piece of land. Under given agroclimatic conditions intense cropping normally requires a greater use of seed, fertilizer, labour and land improvements. Thus cropping intensity and private capital formation were expected to have a positive relationship. The relationship between cropping intensity and private capital formation of the farmers in the developed region was expected to be stronger when compared to that of the farmers in the less developed region. It was expected that in the developed region, due to the higher amount of public capital, farmers will be in a better position to adopt capital intensive cropping techniques in the production process.

Caste

The social structure of Nepali society is determined by the caste system. Historically people belonging to a higher caste were socially, economically and administratively advantaged (Bista, 1976). In addition they are much more concerned with their economic well-being

(Hildreth, 1986). Keeping these factors in mind, a farmer belonging to a higher caste was expected to accumulate more capital in comparison to lower caste farmers.

H. The Hypotheses

Two sets of hypotheses were developed in this study. The first set of hypotheses was developed to test Hirschman's theory of "*development via excess capacity*" and the second set of hypotheses was developed to test the economic justification of public expenditure in public capital formation.

Hypotheses to test Hirschman's Theory of Development Via Excess Capacity

To test Hirschman's theory both direct and indirect hypotheses are developed.

Hypothesis 1. The Direct Hypothesis is that the Availability of Public Capital Determines the Rate of Private Capital Formation: To test this hypothesis the null hypothesis is: the contribution of public capital to private capital formation in the developed and less developed regions are equal. The alternative hypothesis is: the contribution of public capital to private capital formation in the developed region is greater than in the less developed region.

Several indirect hypotheses are formulated about public capital and the economic environment for private capital formation.

Hypothesis 2. The Main Constraint of a Farm Family's Creation of Capital Appears to be Public Capital not their Ability: As reported in Table 2.1, farm families in the less developed region have higher average savings in comparison to the farm families in the developed region. Savings (ability) and capital formation are theoretically positively correlated (Hicks, 1960). Thus, if savings (ability) is the main determining factor in private capital formation, private capital formation in the less developed region should be higher in comparison to the developed region. Whereas, if public capital is the main determining factor in private capital formation, the developed region should have higher average capital formation vis-a-vis the less developed region. To test this view, the null hypothesis is: the contribution of savings to private capital formation in the developed and less developed region are equal. The alternative hypothesis is: the contribution of savings to private capital formation in the developed region is higher in

comparison to the less developed region.

Hypothesis 3. Public Capital as a Limiting Factor to Private Capital Formation: Farm families accumulate capital efficiently, subject to the technical and socio-economic constraints they face (Schultz, 1964). So, a rational farmer will hardly accumulate capital beyond a certain maximum limit, determined by technological and socio-economic constraints. However, formation of public capital is expected to increase this maximum limit. If this hypothesis is true, the formation of public capital will reduce the negative effect of capital stock on private capital formation. As several public capital items have been created in the developed region in the recent past, the farmer's maximum limit to accumulate private capital was expected to have increased in this region vis-a-vis the less developed region. To test this hypothesis, the null hypothesis is: the negative effect of capital stock on capital formation in the developed and less developed regions are equal. The alternative hypothesis is: the negative effect of capital stock on capital formation is smaller in the developed region in comparison to that in the less developed region.

Hypothesis 4. Public Capital as an Incentive to Adopt Capital Intensive Methods of Production:

(a)The size of land holdings was controlled in this study, so a small variability in the size of the land holdings of the farm families was expected to have little effect on private capital formation. However, due to the higher amount of public capital in the developed region, the farmers in the developed region were expected to use more capital per unit of land in comparison to the farmers in the less developed region. To test this hypothesis, the null hypothesis is: private capital formation due to the variation in the size of land holdings is equal in both regions. The alternative hypothesis is: private capital formation, due to the variation of the size of land holdings, is higher in the developed region vis-a-vis the less developed region.

(b) The geophysical conditions of the two study areas are similar resulting in similar cropping intensities. So, the cropping intensity may not have a significant effect on private capital formation under this condition. However, due to the higher amount of public capital in the developed region, the relationship between cropping intensity and private capital formation in the developed region was expected to be stronger when compared to that of the

less developed region. To test this idea, the null hypothesis is: private capital formation, due to the variation in cropping intensity, is equal in both regions. The alternative hypothesis is: capital formation, due to the variation in cropping intensity, is higher in the developed region in comparison to the less developed region.

Hypothesis 5. Caste as an Influencing Factor in Private Capital Formation: The farmers belonging to the higher caste were expected to accumulate more capital in comparison to the lower caste farmers. To test this hypothesis, the null hypothesis is: higher and lower caste farmers, with equal size of land holdings, accumulate equal amounts of capital. The alternative hypothesis is: with equal size of land holdings, higher caste farmers accumulate more capital in comparison to lower caste farmers.

Hypothesis 6. Literacy as a Determining Factor in Private Capital Formation: The literate farmers were expected to accumulate more capital in comparison to illiterate farmers. To test this hypothesis, the null hypothesis is: literate and illiterate farmers accumulate equal amounts of capital. The alternative hypothesis is: literate farmers accumulate more capital in comparison to illiterate farmers.

Hypotheses to Test the Economic Justification of Expenditure in Public Capital

The economic justification of public expenditure in public capital was tested using Griliches (1964) technique. Public capital was included as an independent variable in an agricultural production function to facilitate the test. Direct and indirect hypotheses were developed to perform the test.

Hypothesis 7. The Direct Hypothesis to Test the Economic Justification of Expenditure in Public Capital: Public capital was expected to contribute to agricultural production in ways similar to other factors of production. The increase in public capital was expected to increase agricultural production. To test this hypothesis, the null hypothesis is: the contribution of public capital to agricultural production in the developed and less developed regions are equal. The alternative hypothesis is: the contribution of public capital to agricultural production is greater in the developed region in comparison to the less developed regions.

Hypothesis 8. The Indirect Hypotheses to Test the Economic Justification of Public

Expenditure in Public Capital:

(a) Public capital increases production by augmenting factors of production (Meade, 1952; McMillan, 1979; Manning & McMillan, 1982). Higher productivities of the factors of production in the developed region in comparison to the less developed region constitute evidence of the factor augmenting character of public capital and are a justification for expenditure in public capital. To determine the validity of this hypothesis, the null hypothesis is: the productivities of the normal factors of agricultural production (land, labor, capital,) in both regions are equal. The alternative hypothesis is: the productivities of the normal factors of agricultural production in the developed region is higher than that in the less developed region.

(b)The increase in agricultural production due to cropping intensity was expected to be higher in the developed region in comparison to the less developed region. This was expected, because the developed region enjoys a higher level of external economies generated from public capital when compared to the less developed region. The null hypothesis is: the increase in agricultural production due to the increase in cropping intensity in developed and less developed regions are equal. The alternative hypothesis is: the increase in agricultural production due to the increase in cropping intensity in the developed region is higher in comparison to the less developed region.

I. Specification of the Model

The regression equations for private capital formation and the agricultural production functions were specified to test the hypotheses developed in the previous section. Two alternative regression equations, one with the value of public capital and the other with the level of development, were specified. The functional form and the expected relationship between the dependent and independent variables are presented in this section. [22]

[22]The model specified in this study is similar to Chow's (1957) model. Summary of Chow's model and the functioning of this model is presented in Appendix IX.

Private Capital Formation

The variables included in private capital formation (PCF) equations were, value of public capital (VPC), level of development (D_1, a dummy variable, developed region equal to one, zero otherwise) , savings (S), capital stock (CS), cropping intensity (CI), caste (D_2, a dummy variable, higher caste equal to one, zero otherwise) and literacy of the head of the farm family (D_3, a dummy variable, literate equal to one, zero otherwise).

The two alternative functional forms of private capital formation identified for this study were as follows:

$$PCF = F [S, CS, CI, VPC,].....(1)$$

$$PCF = G [S, CS, CI,].....(2)$$

Where, F and G stands for function.

The specific functional forms selected to estimate the relationship between dependent and independent variables were unrestricted Cobb-Douglas production functions, as follows:

$$PCF = A\, S^{\alpha_1}\, CS^{\alpha_2}\, CI^{\alpha_3}\, VPC^{\alpha_4} ...(3)$$

$$PCF = B\, S^{\beta_1} CS^{\beta_2} CI^{\beta_3} ...(4)$$

The functional forms were converted into logarithms, as follows:

$$\text{Log PCF} = A + \alpha_1 \text{Log S} - \alpha_2 \text{Log CS} + \alpha_3 \text{Log CI} + \alpha_4 \text{Log VPC} +$$

$$\alpha_5 D_2 + \alpha_6 D_3 .....(5)$$

$$\text{Log PCF} = B + \beta_1 \text{Log S} - \beta_2 \text{Log CS} + \beta_3 \text{Log CI} + \beta_4 D_1 +$$

$$\beta_5 D_2 + \beta_6 D_3 .....(6)$$

Where: α_i and β_i are the elasticities of private capital formation with respect to the corresponding independent variables. The signs indicated above correspond to the hypotheses of the study. Equations (5) and (6) are the basic estimating equations for private capital formation.

The independent variables savings, cropping intensity, value of public capital, regional dummy, literacy of the head of the farm family and caste are expected to have positive relationships with private capital formation. The relationship between capital stock and capital formation is expected to be negative.

Agricultural Production Function

The independent variables for the two specifications of production functions are land (N), labour (L), private capital (K), value of public capital (VPC), level of development (D_1, a dummy variable, developed region equal to one, zero otherwise), caste (D_2, a dummy variable, higher caste farmer equal to one, zero otherwise), literacy (D_3, a dummy variable, litetate farmer equal to one, zero otherwise) and cropping intensity (CI).

Symbolically, the two alternative functional forms of the production function are as follows:

$$Q = H (N, L, K, CI, VPC,).....(7)$$

$$Q = J (N, L, K, CI,).....(8)$$

Where, H and J stand for function and Q is total value of agricultural product.

The Cobb-Douglas production function is the most usual functional form used to employ Griliches' technique of finding the sources of growth (Akino & Hayami, 1974). So, the log-linear Cobb-Douglas functional form was selected to use Griliches' technique. The specific functional forms used in this study are as follows:

$$\text{Log } Q = A + \alpha_1 \text{ Log } N + \alpha_2 \text{ Log } L + \alpha_3 \text{ Log } K + \alpha_4 \text{ Log } CI + \alpha_5 \text{ Log } VPC + \alpha_6 D2 + \alpha_7 D3.....(9)$$

$$\text{Log } Q = B + \gamma_1 \text{ Log } N + \gamma_2 \text{ Log } L + \gamma_3 \text{ Log } K + \gamma_4 \text{ Log } CI + \gamma_5 D1 + \gamma_6 D2 + \gamma_7 D3.....(10)$$

Where, α_i and γ_i are output elasticities with respect to the corresponding factors of productions. The expected sign of all the coefficients are positive. Equations (9) and (10) are the basic estimating equations for the production function.

IV. Results of the Study

This chapter is divided into four parts. In the first part the effect of public capital and level of development on private capital formation of the farm families will be presented. In the second part agriculture production functions will be estimated to identify public capital as a significant factor of production and to estimate the effect of the level of development on agricultural production. In the third part the contribution of public expenditure to agricultural production and private capital formation will be calculated. The total contribution of public expenditure in agricultural production will be presented. Finally, in the fourth part the limitations of the results will be given.

A. Performance of the Private Capital Formation Functions

The observed F-values of all the regression equations presented in Table 4.1 and 4.2 are significant at the one percent confidence level. Statistically the capital formation models are adequately specified. The total explanatory power of the independent variables is more than thirty percent with an F of more than 6.9. For cross sectional data, the R^2 of more than 0.30 may be considered reasonably good. Intriligator (1978, p. 126) states "*When using cross-section data,..... R^2 values tend to be low because of both the great variability that is possible across the individual entities and the lack of a common underlying trend*". Capital formation being a behavioral function, a relatively low R^2 may be expected. Capital formation in a subsistence agriculture may be expected to be relatively static. For these reasons, the estimated equations may be considered to be well specified. [33]

The estimated coefficients of the regression equations are statistically efficient for the following reasons. The independent variables are not highly correlated (Appendix VII). In the estimated regressions there is no regression equation with a high R^2 and low t-ratio. This evidence suggests that the estimated regression lines do not suffer from multicollinearity. The disturbance terms were not heteroscedastic. The Goldfield-Quandt test was used on each quantifiable independent variable to test the violation of the assumption of

[33] A similar view can be found expressed by Aghevli & Khan (1977).

TABLE 4.1 Effect of Public Capital on Private Capital Formation, Surkhet District, Nepal, 1986.

Variables.	Regression Equations. 1	2	3	4
Constant.	2.63**	-2.11	-0.53	-2.11
Savings.	0.65***	0.76***	0.71***	0.76***
Capital Stock.	-0.08**	-0.12***	-0.14***	-0.10**
Public Capital	-	0.28***	0.19*	0.29***
Upper Caste=1	-	-	0.52**	-
Literate=1	-	-	-	-0.29
R^2	0.25	0.31	0.35	0.32
Adj. R^2	0.22	0.27	0.32	0.28
F-Value.	11.1***	9.8***	9.1***	7.8***

Note: Level of significance: *** = 1 %, ** = 5 %, * = 10 %.

constant variance of the disturbance term. The disturbance terms were found to be constant. In cross-sectional data, problems with serial correlation are very rare and, as expected, there were none. The dependant variables are normally distributed (For K-S-test refer to Appendix VIII).

Except for education, all independent variables have the correct sign. Except for regression No. 3 in Table 4.1, the estimated coefficients did not change their magnitude when new variables were added to or subtracted from the regression equations. With the addition or subtraction of variables from the regression equations, the direction of the estimated coefficients do not change. The estimated coefficients are consistent (Griliches, 1964).

In all but regression No. 1 in Table 4.1, the constant terms are insignificant suggesting that the variability of the dependent variable is statistically explained by the included independent variables (Robinson, 1971). Needless to say there could be some other explanatory variables not included in the specified equations, but they seem to be proxied by the included variables. The excluded variables are expected to be correlated with the included variables (like income & savings). So, the estimated coefficients could have been over as well as under estimated depending upon the relationship between excluded and included variables and the variability of the excluded variable (Griliches, 1957).

Effect of Public Capital Formation on Private Capital Formation

To test the explanatory power of public capital formation on private capital formation, regressions No. 1 and 2 in Table 4.1 were estimated without and with public capital as an independent variable respectively. In regression No. 2 when public capital was included as an independent variable, the constant term became insignificant. This indicated that the unexplained variability of private capital formation in regression No. 1 was due to the absence of public capital as an independent variable (Robinson, 1971). The addition of public capital was statistically justified, because the increase in R^2 in regression No. 2 in comparison to regression No. 1 is statistically significant (F-test)[24]. Also public capital as an

[24] R^2 was tested using an F-test at the five percent confidence level. For details see Kmenta, (1971, p. 370-73) or Goldberger, (1964, p. 174-75).

independent variable is significant at the 1% confidence level (t-test). These tests suggest that public capital is a legitimate independent variable in private capital formation. Further, the estimated elasticity suggests 28 percent of the variability in private capital formation is explained by public capital formation.

In regression No. 3 caste was introduced as an independent variable to determine the difference in private capital formation between upper caste farmers and lower caste farmers. A dummy variable was used in which upper caste was one and the other castes zero. Caste as an independent variable is significant at the 5% confidence level (t-test). The increase in R^2 due to the inclusion of the dummy variable was significant at the five percent confidence level (F-Test). This result suggests that the farmers belonging to an upper caste create more private capital than lower caste farmers. In this regression the estimated coefficient of public capital decreases significantly and the variable itself is significant only at 10 % confidence level (t-test). The statistical interpretation of this result is that the two variables, caste and public capital, are correlated. The socio-economic interpretation of this result is that the upper caste farmers, who traditionally are in the upper strata of the social system of Nepal, take more advantage from public capital to form private capital in comparison to the lower caste farmers. The upper caste farmers may be taking advantage of their domination in the political system, since the majority of the local leaders were found belonging to the higher caste. It may be that not only are the higher caste political leaders taking advantage of their own positions but the higher caste farmers as a group may be gaining advantage from positions held by relatives and friends. Social and marital arrangements within the higher castes ensure that relationships are important in public decision making.

A dummy variable for the literacy of the head of the farm family was used in regression No. 4 to determine the effect of education on private capital formation. Literacy of the head of the farm family is statistically insignificant (t-test). The inclusion of this variable did not increase the R^2 of the regression (F-test at 5%). This result suggests that the present level of education of the farmers is not playing a significant role in private capital formation.

Effect of Level of Development in Private Capital Formation

In regression No. 1 Table 4.2, the intercept dummy (developed Region = 1, and 0 otherwise) was introduced to determine the effect of the level of development in private capital formation. The coefficient of the dummy variable is significant at the 1% confidence level (t-test). The increase in R^2 due to the inclusion of the dummy variable is significant at the 5% confidence level (F-test). Thus this result indicates that in the developed region, the level of private capital formation is higher than in the less developed region.

Regressions No. 2 and 3 in Table 4.2, were estimated to determine the difference in private capital formation in the developed and less developed regions. To accomplish this objective the slope dummies for savings (or ability of the farmers) and capital stock were introduced in regression No. 2 and 3 respectively. The increases in R^2 due to the inclusion of the slope dummies are significant at 5% (F-test). The slope dummies are significant at the 5% confidence level (t-test). The significance of the slope dummies suggests that the farmers in the developed and less developed regions accumulate private capital differently. In the developed region the explanatory power (the contribution to R^2) by savings (or ability of the farmers) on private capital formation is 77%, whereas, in the less developed region it is only 72%. The higher explanatory power of the ability of the farmers in private capital formation in the developed region indicates that the farmers in the developed region have higher absorptive capacity (Milikan & Rostow, 1956; Meier & Bolwin, 1957)[25] or a higher ability to invest (Hirschman, 1960) in comparison to the farmers in the less developed region. The farmers in the developed region accumulate more capital in comparison to the farmers in the less developed region, because they have more investment opportunities in private capital in comparison to the farmers in the less developed region. In the same manner, the negative effect of capital stock on private capital formation in the developed region is 5% less than that in the less developed region. The lower negative effect of private capital stock on private capital formation in the developed region in comparison to the less developed region indicates that the required level of private capital is higher to achieve an efficent combination with

[25]Cited in Hirschman, (1960, p. 37).

TABLE 4.2 Effect of Level of Development on Private Capital Formation in Developed & Less Developed Regions Represented by Dummy Variables, Surkhet District, Nepal, 1986.

Variables.	Regression Equations. 1	2	3	4	5
Constant.	1.69	1.95	2.08	2.02	1.16
Savings .	0.75***	0.72***	0.72***	0.73***	0.74***
Capital stock.	-0.12***	-0.12***	-0.13***	-0.12***	-0.12***
Developed region.	0.46***	-	-	-	-
Slope of Savings.	-	0.05**	-	-	-
Slope of Capital Stock.	-	-	0.05**	-	-
Land.	-	-	-	-0.05	-
Slope of Land.	-	-	-	0.15**	-
Cropping Intensity.	-	-	-	-	0.11
Slope of Cropping Intensity.	-	-	-	-	0.09**
R^2	0.30	0.30	0.28	0.30	0.30
Adj. R^2	0.27	0.27	0.25	0.25	0.26
F-Value.	9.5***	9.6***	8.8***	6.9***	7.1***

Note: Level of significance: *** = 1 %, ** = 5 %, * = 10 % .

public capital in the developed region than in the less developed region. Due to the higher required level of private capital, farmers in the developed region are accumulating more private capital than the farmers in the less developed region. The higher absorptive capacity and the lower negative effect of private capital stock on private capital formation in the developed region in comparison to the less developed region may be credited to the higher amount of public capital in the developed region. This interpretation is enabled by the research design in which, except for public capital facilities and human behaviour, the two regions are similar to each other.

Public capital as a bundle of goods and services may be termed as technology. The higher amount of public capital in the developed region in comparison to the less developed region signifies the higher technological level in that region. The higher level of private capital formation in developed region in comparison to the less developed region may be an indication that the traditional subsistence farmers behave rationally in the sense that they allocate their resources according to the technical constraint they face.

Size of land holdings and cropping intensity were expected not to have a significant effect on private capital formation. In fact, these variables are insignificant. However, to find the regional difference in private capital formation due to size of land holdings and cropping intensity, regressions No. 4 and 5 were estimated including the slope dummies of size of land holdings and cropping intensity. In both of the estimated regression equations the inclusion of the slope dummies were justified, because the increase in R^2 was significant at the 5% confidence level (F-test). The slope dummies are significant at 5% confidence level (t-test). The significance of the slope dummies associated with the size of land holdings and cropping intensity suggests that the 15 % and 9% variation in private capital formation in the developed region is explained in the variation of size of land holdings and cropping intensity respectively. In contrast, these variables have no explanatory power at all in the less developed region. These results indicate the indirect contribution of public capital (or level of development) to private capital formation. These result also indicate the factor augmenting character of public capital.

The sums of the coefficients for each of the estimated regression equations are consistently less than one. This result indicates that a one percent increase in the independent variables will increase private capital less than one percent, i.e. private capital increases at a diminishing rate. However, all the estimated equations with slope dummies suggest the rate of capital accumulation in the developed region is higher than in the less developed region.

B. Performance of the Agricultural Production Function

Two sets of production functions were estimated to determine the effect of public capital and level of development on the value of agricultural output. In the first set, public capital was included as an independent variable, which is presented in Table 4.3. In the second set a dummy variable (Developed Region = 1, and 0 otherwise) was included as an independent variable, which is presented in Table 4.4.

Overall the estimated regression equations presented in Table 4.3 and 4.4 are significant at the one percent confidence level (F-test). The explanatory power of the independent variables is more than seventy percent with F-values of more than 32.2. This value of R^2 is high for cross-sectional data. All estimated coefficients of the independent variables have correct signs. The magnitudes of the coefficients appear to be reasonable. The common independent variables, land and labour, are significant at less than 5% confidence levels (t-test). The value of private capital formation as an independent variable is mostly significant between 5 to 10% confidence levels (t-test). All the estimated coefficients are remarkably stable when new variables are added or subtracted. The estimated coefficients of the independent variables are statistically efficient because the dependent variable is normally distributed (Appendix VIII). The independent variables are not highly correlated and variances of the disturbance terms are found to be constant.[24].

[24] The correlation coefficents between the independent variables were less than 0.55 (Appendix VII). When the Goldfield-Quandt test was applied to each of the quantitative independent variables to test the variance of the disturbance term, the variance was found to be constant.

TABLE 4.3 Effect of Public Capital on Agricultural Production, Surkhet District, Nepal, 1986.

Inependent Variables.	Regression Equations. 1	2	3	4
Constant.	4.50***	2.86***	-0.49	-0.29
Land.	0.14	0.28***	0.36***	0.37***
Labour.	0.74***	0.66***	0.59***	0.57***
Private Capital.	0.07**	0.06*	0.07**	0.07*
Public Capital.	-	0.13***	0.11***	0.09**
Cropping Intensity.	-	-	0.67***	0.68***
Literacy.	-	-	0.17**	0.16**
Caste.	-	-	-	-0.08
R^2	0.67	0.71	0.75	0.75
Adj. R^2	0.65	0.69	0.73	0.73
F-Value.	45.5***	39.6***	32.2***	27.7***

Note: Level of significance: *** = 1 %, ** = 5 %, * = 10 % .

Effect of Public Capital on Agricultural Production

Regressions No. 1 and 2 in Table 4.3 were estimated, specifying public capital as one of the main factors of production, No. 1 without public capital and No. 2 with public capital. Then the two regressions were compared. Even though the constant term in the regression No. 2 is significant at the one percent confidence level, it is smaller than the constant term in regression No. 1 [17]. This evidence suggests one of the omitted variables having explanatory power but not correlated with the included variables in regression No. 1 is public capital (Robinson, 1971; Griliches, 1957). The R^2 of regression No. 2 is significantly higher than the R^2 of regression No. 1 (F-test at 5%). Public capital as an independent variable in regression No. 2 is significant at the 5% confidence level (t-test). Statistically, public capital is one of the important factors in agricultural production.

As indicated in the preceding paragraph, regressions No. 1 and 2 cannot be considered as well specified, because the constant term is significant at the 1% confidence level (t-test). Consequently in regression No. 3 cropping intensity and literacy [18] of the head of the farm family were included. With the following reasons regression No. 3 has better fit than regression No. 1 and 2. The constant term is insignificant. The increase in R^2 due to the inclusion of these variables is significant at the one percent confidence level (F-test). The level of significance of land, labour, capital and public capital increases significantly. And the included variables cropping intensity and literacy of the head of the farm family are significant at the one and five percent confidence level (t-test). The statistical significance of literacy of the head of the farm family in the regression equation suggests that literate farmers produce more agricultural output in comparison to illiterate farmers, other factors remaining the same. Under similar circumstances the literate farmers produce more agricultural output in comparison to the illiterate farmers because they are more efficient. This result indicates that there may be some room to increase agricultural output just by educating the farmers because education can increase the allocative, selective and technical efficiency of the farmers (Welch, 1970; Nelson & Phelps, 1966).

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[17] Which suggests there are some other left out variables having significant explanatory power.
[18] A dummy variable.

Caste as an independent variable, regression No. 4 Table 4.3, is not significant. With the help of this result we may say, other things remaining the same, the lower and upper caste farmers produce equal amount of agricultural output. That is to say, the production possibility curve of the lower and higher caste farmers are statistically similar.

With the help of regression No. 3 we may conclude that eleven percent of the variability in agricultural output is explained by public capital formation. This result indicates the firm augmenting character of public capital.

Effect of Level of Development on Agricultural Production

In regression No. 1 Table 4.4 a regional dummy (Developed Region = 1, and zero otherwise) was included to determine the effect of level of development on agricultural production. The inclusion of the dummy variable was justified, because the increase in R^2 due to the inclusion of the dummy variable was statistically significant at 5% (F-test). The dummy variable itself is significant at the 5% confidence level (t-test), signifying that the two regions are different in terms of agricultural production. The coefficient of the dummy variable has a positive sign, as expected. This positive sign indicates that agricultural production in the developed region, other things remaining the same, is higher than in the less developed region.

Regressions No. 2 through 5 in Table 4.4, include the slope dummies (Developed Region = 1, 0 otherwise.) for land, labour, capital and cropping intensity respectively. The main purpose of including slope dummies in these production functions was to find the effect of the level of development on the explanatory power of the factors of productions. In all the regression equations, the increases in R^2 due to the inclusion of slope dummies are significant at the 5% confidence level (F-test). Except for land, the slope dummies, in each of the regression equations, are significant at 1% confidence level (t-test). The slope of the land, a slope dummy, is significant at the 5% confidence level (t-test). As expected, the signs of the dummy variables are positive. All the results of the estimated regression equations indicate

TABLE 4.4 Effect of Level of Development on Agricultural Production in Developed & Less Developed Regions Represented by Dummy Variables, Surkhet District, Nepal, 1986.

Variables.	Regression Equations. 1	2	3	4	5
Constant.	4.44***	4.56***	4.55***	4.54***	1.22
Land.	0.27**	0.22***	0.26***	0.26***	0.33***
Labour.	0.68***	0.69***	0.66***	0.66***	0.63***
Capital.	0.06*	0.06*	0.06*	0.05	0.05*
Developed Region.	0.20***	-	-	-	-
Slope of Land.	-	0.06**	-	-	-
Slope of Labour.	-	-	0.04***	-	-
Slope of Capital.	-	-	-	0.02***	-
Cropping Intensity.	-	-	-	-	0.64***
Slope of Cropping Intensity.	-	-	-	-	0.04***
R^2	0.70	0.70	0.70	0.70	0.73
Adj. R^2	0.68	0.68	0.68	0.68	0.71
F-Value.	38.5***	37.8***	38.3***	38.3***	34.5***

Note: Level of significance: *** = 1 %, ** = 5 %, * = 10 % .

that the factors of production, in the developed region, have higher productivity in comparison to the less developed region. These results indicate the factor augmenting character of public capital.

The estimated production functions persistently show the presence of economies of scale. If all the factors of productions are increased by one percent agricultural output will increase more than one percent.

C. The Contribution of Public Expenditure in Private Capital Formation and Agriculture Production

To calculate the contribution of public expenditure to private capital formation and agricultural production, it was assumed that public capital was solely an outcome of public expenditure. This assumption was made to enable use of the elasticity of public capital from the private capital formation and agricultural production functions.

In the second and third columns of Table 4.5, the contribution of public expenditure to agricultural production and private capital formation respectively are presented. In the fourth column the contribution of private capital formation to agricultural production is presented. In column five, the contribution of private capital to agricultural production due to public expenditure is calculated[29]. In column six, the total contribution of public expenditure to agricultural production is presented[30]. The contributions are on a per farm per Rupee basis. The results are interpreted as follows. In the less developed region, one Rupee of government expenditure per farm family in public capital contributed to increase farm family agricultural production in two ways:

1. It directly helped farmers to increase agricultural production by 3.77 Rupees worth.
2. It motivated the farm families to accumulate 4.06 Rupees worth of private capital. This 4.06 Rupees worth of private capital contributed to increase 0.406 Rupees worth of agricultural production.

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[29] Product of column 3 and 4, Table 4.5.
[30] Summation of the second and fifth column, Table 4.5.

Table 4.5 Social Rate of Return of Public Expenditure in Developed and Less Developed Regions of Surkhet District, Nepal 1986.

Region & Panchayat.	Contribution of Expenditure on Public Capital to: Ag. Production.	Pvt. Cap. Formation.	MP of Private Capital.	Ag. Prodn. via Pvt. Cap.	Ag. Prodn. in Total.
Less Developed.	3.77	4.06	0.10	0.406	4.18
Tatapani.	3.46	3.46	0.107	0.37	3.83
Ghatgaun.	4.38	5.32	0.089	0.473	4.85
Pokharikanda.	4.28	4.48	0.103	0.461	4.74
Developed Region.	1.93	2.03	0.143	0.29	2.22
Ramghat.	1.49	1.84	0.122	0.224	1.71
Dasrathpur.	1.65	0.99	0.251	0.248	1.90
Sahare.	2.89	4.43	0.098	0.434	3.32

Note:

(a) To calculate marginal product of public expenditure in agricultural production, the elasticity 0.13 from regression No. 2 Table 4.3 was used.

(b) To calculate marginal product of public expenditure in private capital formation the elasticity 0.28 from regression No. 2 Table 4.1 was used.

(c) To calculate marginal product of private capital on Ag. production the elasticities 0.05 and 0.07 from regression No. 4 Table 4.4, were used for less developed and developed regions respectively.

The total increase in agricultural production per farm family due to a one Rupee per farm worth of government expenditure in public capital was 4.18 Rupees. The rest of the results may be interpreted in a similar manner.

Finally, the social rate of return of public expenditure in the less developed region is higher than that in the developed region. These results suggest that the law of diminishing returns applies to public expenditure.

D. Limitations of the Results

The contribution of public expenditures has been calculated using Griliches (1964) well accepted growth accounting technique (Akino & Hayami, 1974). Griliches' technique is valid only under the assumptions of perfect competition and equilibrium in the factor market. The market structures in the study area do not seem to fulfill these assumptions, because the price of factors as well as products are not determined by a competitive market mechanism. Market are poorly developed. Barter is the main form of transaction. Almost all farm families are sellers of some kind of agricultural product, whereas the buyers are limited. So it is a buyers market. Other than agriculture there is hardly any other sector in existence. Consequently the opportunity cost of the factors of production other than land are almost nil. So, those limiting assumptions might have affected the results.

The cost of family labour devoted to forming private capital was not included in this study. It was assumed that unpaid family labour used in construction had zero opportunity cost. This assumption is realistic as long as no more supplementary hired labour was used in one region over the other. Exclusion of family labour value in private capital formation might have biased the result upwards in the developed region where hired labour may have been used and reported by respondants of higher caste.

The method of estimating the social rate of return of public expenditure is mechanistic, in that except for private capital, all variables were assumed constant[31]. However, in the short run the variables land, labour, public capital, savings and capital stock are more or less constant. So, this assumption may not be a serious limitation of the study.

[31] i. e. This is a partial equilibrium analysis.

Elasticities estimated with the help of the OLS method were used to calculate the social return on public expenditure. As the sum of the residuals of the regression equations are zero over the sample, so the regression equations may over as well as under estimate the elasticities of the independent variables (Robinson, 1971). For this reason, the social rate of return of public expenditure might have been under as well as over estimated. The probability of underestimation is higher in this study, because the benefits from public capital were confined to those farm families who are in the same panchayat where the public capital is located. In reality the benefit of public capital is enjoyed by farm families beyond the boundaries of the panchayat where it is located. The social rate of return of public expenditure is higher, the higher the number of farm families. The number of families using public capital facilities in this study is definitly lower than the actual number, because the consumption of public services is not restricted to any one panchayat. This pattern of use of public capital can be seen in the flow of services table in Appendix VI.

The questionnaire was long. Some of the respondents might have been bored answering the lengthy questionnaire, so they might have given wrong information. The questions concerning time of possession and durability of capital goods were difficult to answer. The farmers did not maintain farm records, so their answers were entirely based upon their memory recall. As one can not remember each and every thing, the respondents might have given wrong as well as guessed information.

The sample size was selected based on the budget restraint, which is not a statistically preferred method. As there was no source of information about the standard deviations of the variables, a statistically consistent method of determining the sample size was not feasible. The hypothetically selected sample size might not have generated efficient (minimum variance) estimates of the means. However the numbers of observations were sufficient to use large sample statistical techniques. So the precision of the results is considered to be statistically acceptable.

Since the Cobb-Douglas production function assumes an unitary elasticity of substitution among the factors of production, it excludes the possibility to analyse complementary relationships among the factors of production. For this reason, the analytical

power of the Cobb-Douglas production function, for short run analysis, is not considered very strong. According to Heathfield (1971) the Cobb-Douglas production function should not be used to analyse short run problems. As this study is based upon cross-sectional data, the results derived with the help of the Cobb-Douglas production function may not be precise.

V. Summary and Conclusions

A. Summary

The primary objective of this study was to test the hypothesis that the level of public capital influences private capital formation in subsistence agriculture. A second objective was to estimate the effect of public capital on agricultural production. The third objective was to determine the economic rationale of public capital formation. And the fourth objective was to determine the distributional effect of public expenditure. Evidence was obtained from the Surkhet District of Nepal. A comparative study was designed to accomplish these objectives and to test the hypotheses of the study. A relatively developed region and a relatively less developed region of Surkhet District were identified for comparison purposes. The developed and less developed regions were selected from within one agroclimatic zone. The research was confined to farmers with land holdings between 0.35 ha. to 2.1 ha. to minimise the distributional effect of public capital, due to the size of land holdings. The production function approach of finding the sources of growth, developed by Griliches (1964) was used to achieve the objectives. An unrestricted general production function of the Cobb-Douglas type fit the data best. Private capital formation and agricultural production of the farm families in the developed and less developed regions were compared with the help of an intercept dummy variable. Slope dummies were used to compare the contribution of the independent variables to the dependent variables in the developed and less developed regions. Finally, the social rate of return of expenditure on public capital formation was calculated to determine the economic justification of public capital formation.

The independent variables in the private capital formation equation were: ability of the farmers to save (savings), capital stock, public capital, size of land holdings, cropping intensity, caste and education. Savings, capital stock, size of land holdings, and cropping intensity were used to test Hirschman's theory of *development via excess capacity*. The statistical significance of the value of public capital in private capital formation confirmed Hirschman's theory. Private capital stock and formation in the developed region were found to be significantly higher in comparison to the less developed region, indicating a positive

relationship between private capital formation and public capital formation.

The significantly higher explanatory power of the variables, saving ability, size of land holdings and cropping intensity in the developed region vis-a-vis the less developed region conform with Hirischman's theory. These results were a clear indication of the higher level of *absorptive capacity* (Milikan, & Rastow, 1957; Meier, & Bolwin, 1957)[32] or *ability to invest* (Hirschman, 1960) in the developed region in comparison to the less developed region. The higher level of *absorptive capacity* in the developed region was created by the higher amount of public capital in that region all other things being equal.

An inverse relationship between private capital stock and private capital formation was determined to exist in both regions. The lower coefficient for the developed region indicated the demand for private capital (capital formation) in the developed region was significantly higher in comparison to the less developed region. On the one hand, public capital, in the form of schools, communication services and agricultural service centers develops farmers' ability to adopt new techniques of agricultural production. On the other hand, public capital, in the form of roads, markets, co-operatives and input supplies, provides farmers the necessary inputs to use these techniques. So, the higher demand for private capital in the developed region may be attributed to a higher amount of public capital.

In a less developed region of a developing country, public capital, a bundle of goods and services, determines the level of technology. The higher the amount of public capital the higher will be the level of technology and vice-a-versa. The higher level of private capital formation in the developed region in comparison to the less developed region supports Schultz's (1964) view that the traditional farmers in the subsistence agricultural sector behave rationally and that their allocation of resources depends upon the technical constraints they face. This result indicates that in the subsistence agricultural sector of a developing country, public capital plays a major role in farm families' acccumulation of private capital.

Public capital, cropping intensity and caste were included with private capital and labour as inputs in the production function. The difference in the level of agricultural output between the developed and less developed region suggested the existence of a positive

[32]Cited by Hirschman (1960, p. 37).

relationship between public capital formation and agricultural production.

Public capital is thought to influence private decisions on resource combinations through externalities. These externalities were tested by comparing the productivities of the factors of production in the developed and less developed regions. As expected, the productivities of the factors of productions in the developed region were significantly higher in comparison to those in the less developed region. The variation in cropping intensity had significantly higher explanatory power in the developed region vis-a-vis the less developed region. This result lent further support to the existence of a higher level of technology in the developed region in comparison to the less developed region.

The distributional effect of public capital was tested against caste and education of the farmers. These two variables were used anticipating that farmers belonging to a higher caste and who are literate may benefit more from the creation of public capital than farmers belonging to a lower caste and who are illiterate. These phenomena would not likely be confined to one area within the western part of the district. Consequently the test was made with the pooled data of both regions. Caste constituted a significant influence on private capital formation, whereas it was insignificant in agricultural production. These results suggest that the upper and lower caste farmers are on the same production possibility curve regardless of the technique they use. In terms of techniques of production, the upper and lower caste farmers use capital intensive and labour intensive techniques respectively.

As public capital contributes significantly to private capital formation, farmers using capital intensive techniques of production benefit more in comparison to the farmers using labour intensive techniques. So, the result indirectly indicates the upper caste biased distributional effect of public capital. The results also suggest that the distributional effect of caste on public capital formation works through its factor augmenting character rather than through firm augmentation.

Literacy, in contrast to caste, was significant in agricultural production, but insignificant in explaining capital formation. The results appear awkward, but they are consistent with Welch (1970) and Nelson & Phelps's (1966) theories of education. These results are interpreted in the following manner. An educated farmer produces higher

agricultural output, because of his technical (worker effect of Welch, 1970), allocative and selective efficiencies. That is to say, the educated farmers are more productive, because knowingly they do not waste resources. They employ inputs in the proper ratio and they select the right amount of input in the production process. The increase in efficiency due to education has nothing to do with the factors of production such as level of capital formation. Thus the effect of education on private capital formation and agricultural production would not be related. However the upper caste farmers are more literate than the lower caste farmers (survey results). As the literacy of a farmer is a result of public capital (in the form of schools), the upper caste farmers benefit more from public capital than do the lower caste farmers. This result suggested education as one of the sources of agricultural growth. So, formation of public capital in the form of schools may be one of the ways to develop the subsistence agriculture of Nepal. Literacy (education) in its relationship to private capital appears to be firm augmenting rather than capital augmenting. In this case the firm is the farm family organisation.

The social rate of return, in this study, is interpreted as the additional tangible benefit realised by the farm families due to public expenditure in the formation of public capital. The estimated social rate of return seems to be reasonable, because the elasticity of agricultural production with respect to public capital of this study is similar to Easter *et al* (1977) and Antle's (1983) elasticity of agricultural production with respect to infrastructure[33]. The social rate of return calculated in this study confirmed the economic justification of expenditure in public capital. The estimated social rate of return also suggested that public capital demonstrates a diminishing marginal productivity. This was evidenced by the smaller social rate of return of public capital in the developed region in comparison to the less developed region. This result suggests that the formation of public capital in the less developed region is more beneficial in comparison to the developed region.

[33] The estimated elasticity of agricultural production with respect to public capital in this study is 0.13. Easter *et al* and Antle's (1983) estimated elasticity of agricultural production with respect to infrastructure for the districts of India and 47 less developed countries were 0.133 and 0.191 respectively.

B. Conclusions

The hypothesis of this study was that the formation of private capital by subsistence farm families in a less developed district, Surkhet, of a developing country, Nepal, is constrained by the availability of public capital. Public capital was a significant variable explaining private capital formation of the farmers. This result was in conformity with Hirschman's theory of "*development via excess capacity*". The contribution of public capital to the formation of private capital also revealed that farm families in the developed region of Surkhet District accumulate more capital in comparison to farm families in the less developed region of the district.

Considering this result, it may be said that capital formation by subsistence farmers depends upon the availability of public capital. That is to say, Hirschman's view that the formation of private capital in a less developed part of a developing country is possible only after a minimum level of the formation of public capital applies in the Surkhet District of Nepal.

The average ability of the farmers (savings) in the developed region was lower in comparison to the farmers in the less developed region (Table 2.1, Chap. II). However, the formation of private capital was higher in the developed region vis-a-vis the less developed region. This result indirectly suggested that the formation of private capital by subsistence farmers depends upon the availability of public capital. It is because the rate of return of private capital formation (i.e. investment in capital) is higher where investment in public capital has occured. The ability of the farmers (savings) is not the primary determining factor in a subsistence farmer's process of accumulating capital.

The smaller negative effect of existing private capital stock on private capital formation in the developed region suggested that the demand for private capital (capital formation) in the developed region is higher in comparison to the less developed region.

The direct as well as indirect results lend empirical validity to Hirschman's theory. Thus Hirschman's theory may be used to determine polices to hasten capital formation by subsistence farmers in less developed regions of a developing country similar to Nepal.

Considering private capital formation of the farmers as an indicator of agricultural growth and development, the results obtained from the estimated private capital formation equations suggest that agricultural growth and development of a subsistence agriculture sector, like that of Surkhet, is enhanced by the formation of public capital. In a less developed part of a developing country, farm families' ability to invest is not the primary determining factor of agricultural growth and development. The empirical evidence suggests that the subsistence farmers of the Surkhet District behave rationally, because farmers having relatively easy access to public capital were accumulating more capital in comparison to the farmers deprived of the public capital.

The estimated production function equations revealed that the contribution of public capital to agricultural production is positive and statistically significant. The productivities of the factors of production in the developed region were found to be significantly higher than those in the less developed region. These findings lead us to say that public capital plays a significant role in the growth and development of the subsistence agricultural sector of a developing country.

The social rates of return on public expenditure were 222 and 418 percent in the developed and less developed regions respectively. That is to say, 2.22 and 4.18 Rupees worth of additional agricultural output per year were obtained by an additional Rupee of government expenditure in public capital in the developed and less developed regions respectively. This result confirms that public expenditure to form public capital in the Surkhet District of Nepal, where the majority of the farmers are at subsistence level, is economically beneficial. Further, the social rate of return of public expenditure in the less developed region is higher than that in the developed region. Consequently to maximise the social rate of return to scarce financial resources, expenditure should be directed toward the less developed regions of the district, not concentrated in a few panchayats.

In total, the result of this study showed that public capital is one of the essential factors in the development of subsistence agriculture in a less developed region of a developing country. On the one hand it helps farm families to accumulate capital. On the other hand it contributes to increased agricultural production and the productivities of the

factors of production. So, to develop the subsistence farm sector of Nepal, the government should spend more money in public capital because the social rate of return is high.

Finally with the help of the results of this study the following suggestions are made:

(a)The concerned authorities have to create essential public capital facilities to develop the subsistence agriculture sector of a less developed region of a developing country, like Nepal. Formation of public capital is a prerequisite to the formation of private capital and agricultural growth and development.

(b) Literacy (education) of the farmers is one of the sources of agricultural growth and development. However the contribution of education to private capital formation and to agricultural growth and development depends upon the level of technology. So, to maximise the social rate of return from public expenditure in schools, public capital that increases the level of technology should be created first.

(c) In the similar agroclimatic regions, to achieve the maximum social rate of return from expenditure in public capital, public capital should be created evenly. With limited financial resources, formation of public capital in a few regions does not seem to be a proper strategy for rural development.

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Appendix I. Public Expenditure by Sector in Six Development Plans of Nepal

(In Millions of Nepali Rupees)

Sector	Plan					
	1st Plan	2nd Plan	3rd Plan	4th Plan	5th* Plan	6th** Plan
	1956/57-1960/61	1962/63-1964/65	1965/66-1969/70	1970/71-1974/75	1975/76-1979/80	1980/81-1984/85
Agriculture	47	91	285	751	2350	6600
Industry	10	104	83	337	629	1800
Power	13	137	172	174	1049	3800
Transport	95	93	861	1430	2380	4230
Education	21	49	117	284	1028	1660
Health	16	46	91	177	474	1060
Other	12	77	170	188	959	2600
Total	214	597	1779	3341	8869	21750

Sources: 1. 2nd to 6th Plan of Nepal, National Planning Commision, HMG, Nepal.
* Revised Estimate.
** Estimate.

Appendix II. Public Capital Formation in Nepal, Before the First Plan (1956) and at the End of the Fifth Plan (1980)

Public Capital.	Before 1956.	At 1980.
Road (Motorable).	400 Km.	4940 Km.
Airports.	5	39
Publicly Developed Irrigation Facility.	15000 ha.	198481 ha.
Electricity.	6280 Kwt.	79914 Kwt.
Bank (Branches).	8	241
Literary Rate.	2%	22%
Post Office.	124	1358
Telephone Lines.	350	13670
Wireless Services.	28 Places	80 Places
Hospitals.	34	73
Hospital Beds.	649	2586
Health Posts.	24	583

Sources: 1. 2nd to 6th Plan of Nepal, National Planning Commision, HMG, Nepal.
2. Quarterly Economic Bulletin, Nepal Rastra Bank, 1986, Nepal.

Appendix III. Share of Foreign Grants, Loan and Aid in Development Program of Nepal

(In Percent)

Plan.	Percentage of Foreign Grants in Development Budget.	Percentage of Foreign Loan in Development Budget.	Percentage of Foreign Aid in Development Budget.
1st Plan	76.6	—	76.6
2nd Plan	71.0	8.0	79.0
3rd Plan	55.7	0.9	56.6
4th Plan	35.9	8.9	44.8
5th Plan	30.0	21.7	51.7
6th Plan	23.9	24.8	48.7
7th Plan*	25.1	38.9	64.0

Sources: 1. "Budget in Nepal" Revenue Administration Training Centre, HMG / Ministry of finance, Kathmandu, Nepal 1982.
2. "Several Budget Speechs of Nepal". Ministry of Finance / HMG, Nepal Kathmandu, Nepal.

* Based upon the estimated budget of the fiscal year 1985/86 and 1986/87.

Note: The data for the fiscal year 1983/84 is revised estimate of the budget.

Appendix IV. List of Public Capital Projects Used to Rank the Panchayats in Surkhet District of Nepal

1. Panchayat Building.
2. Sagha Office (Co-operative).
3. Police Office.
4. Forest Office.
5. Drinking Water Facility.
6. Office of the Input Corporation.
7. Livestock Service Center.
8. Health Service Center.
   a. Hospital.
   b. Health Post.
   c. Aurbadic Hospital.
9. Education:
   a. Campus.
   b. High School.
   c. Middle School.
   d. Primary school.
10. Financial Service:
    a. Commercial Bank.
    b. Agriculture Bank.
    c. Small Farmers Program.
11. Soil Conservation and Watershed Management Program:
    a. Office or
    b. Any Project.

12. Communication Facility:
    a. Telephone Service.
    b. Telegram Service.
    c. Post Office.
    d. News Paper.

13. Agriculture Extension Services:
    a. Office of the Agriculture Service Center.
    b. Office or Residence of J.T..
    c. Office or Residence of J.T.A..

14. Market:
    a. Naturally Developed Market.
    b. Developed by Governmental (or social) Effort.

15. Irrigation Facility:
    a. Office or
    b. Project.

16. UNICAFE Multipurpose Development Program:

17. Cottage Industry:
    a. Office or
    b. Any Program.

18. Transportation:
    a. Airway Service.
    b. All weather Motorable Road.
    c. Fair weather Motorable Road.
    d. Commercially Important Tracks.
    e. Commercially Important Bridges.

Appendix V. Panchayats of Surkhet District: Climatic- Characteristics and Rankings by Public Capital Project

Name of the Panchayats.	Climate Found in the Panchayats.	Dominant Climate in the Panchayats.	Public Capital Projects in the Panchayats.	Rankings of the Panchayats.
Abalching.	BH,AU,CP	BH	5	15
Agrigaun.	BH,AU	BH	5	15
Babiyachaur.	BH, AU	AU	11	9
Bajedichaur.	Bh, AU	BH	12	8
Betan.	BH, AU	AU	6	14
Bidyapur.	BH, AU	AU	10	10
Bijauro.	BH,AU	AU	9	11
Birendranagar.	BH, AH	AH	38	1
Chapre.	BH, AU	BH	7	13
Chinchu.	BH,AU	AU	14	6
Dahachaur.	BH, AU	AU	4	16
Dadakhali.	BH, AU	BH	15	5
Dasrathpur.	BH, AU	AU	19	2
Darapani.	BH, AU	BH	6	14
Godigaun.	BH, AU	BH	9	11
Garpan.	BH	BH	8	12
Ghatgaun.	BH, AU	AU	4	16
Ghoreta.	BH, AU	AU	6	14
Ghumkhahare.	BH, AU	AU	10	10
Gumi.	BH,AU	AU	13	7
Guthu.	BH, AU	AU	12	8
Hariharpur.	BH, AU, AH	AU	9	11
Jarbutta.	BH, AH	BH	13	7
Kalyan.	AU, AH	AU	8	12
Kaphalkot.	BH, AU	BH	7	13
Kaprichaur.	BH, AU	BH	5	15
Khanikhola.	BH, AU	BH	9	11
Kunathari.	AU	AU	15	5
Lagam.	BH, AU	BH	10	10

Name of the Panchayats.	Climate Found in the Panchayats.	Dominant Climate in the Panchayats.	Public Capital Projects in the Panchayats.	Rankings of the Panchayats.
Latikoeli.	AH	AH	15	5
Lekgaun.	BH, AU, AM	BH	7	13
Lekhparajul.	BH, AU, AH	AU	9	11
Lekhpharsa.	BH, AU	AU	8	12
Maintada.	AU	AU	8	12
Malarani.	BH, AU	AU	7	13
Matela.	BH, CP	BH	12	8
Mehelkuna.	AU	AU	14	6
Neta.	BH, AU	BH	6	14
Pampka.	BH	BH	8	12
Pokharikanda.	BH, AU	AU	5	15
Rajena.	BH, CP	CP	7	13
Rakam.	BH, AU	AU	8	12
Ramghat.	AU	AU	17	3
Ranibas.	BH, CP	BH	7	13
Ratu.	BH	BH	5	15
Sahare.	BH, AU	AU	16	4
Salkot.	BH, AU	AU	6	14
Satakhani.	BH, AH	AH	13	7
Taranga.	BH, AU	AU	7	13
Tatapani.	BH, AU	AU	7	13
Uttarganga.	AH	AH	13	7

Sources: 1. "Land Resource Mapping Project", Kenting Earth Science Limited, Nepal/Canada, 1986.
2. "Surkhet District Summary Report and Atlas". An unpublished Report, Kenting Earth Sciences Limited.
3. "Maps". Topographical Survey Branch, HMG/Nepal.

Legend: BH = Warm Temperate Humid Climate.
AU = Subtropical Subhumid Climate.
AH = Subtropical Humid Climate.
CP = Cool Temperate Perhumid Climate .

Appendix VI. Flow of Services between the Panchayats

(a) The Low Ranking Panchayats in the Eastern Part of the Surkhet District of Nepal*

From / To	Dasrathpur.	Ramghat.	Mehelkuna.	Chinchu.	Lekhpharsa.	Sahare.
Dahachaur.	Developed Seed. Market. High School. Co-operative. Banking.	Ag. Ext.-service. Veterinary Service. Market.	Market. High School.	Market. Forest Service.	Health Service.	N
Lekhpharsa.	Developed Seed. Market. High School. Co-operative. Banking.	Ag. Ext. service. Veterinary Service. Market.	N	Market. Forest. Service.	Health. Service.	N
Maintada.	Developed Seed.	Ag. Ext. services. Veterinary Services. Market.	Market. High School. Cooperative Service.	Market. Forest Service.	N	N

* These Panchayats are close to fair weather motorable road.

N = Not observed.

(b) The low Ranking Panchayats in the Western Part of the Surkhet District of Nepal*

From / To	Kunathari.	Salkot.	Babiyachaur.**	Bidyapur.
Ghatgaun.	N	N	N	Health Service. School.
Pokharikanda.	Veterinary Service.	Health Service.	N	N
Taranga.	Veterinary Service. School.	N	N	N
Tatapani	N	Health Service.	N	Health Service. School.

Source: Survey Results.

N = Not observed.

* = No other Panchayats were close to these Panchayats having Potential to provide services.

** = Have a Service Center, but due to lack of human and physical resources it is inactive.

(c) The High Ranking Panchayats in the Eastern Part of the Surkhet District of Nepal*

From / To	Dasrathpur.	Ramghat.	Sahare.	Mehelkuna.	Lekhpharsa.	Chinchu.
Dasrathpur.		Ag. Ext. Service. Veterinary Service. Market.	N	N	Health Service.	Health Service. Market. Ag. Inputs. Forest Services.
Ramghat.	Market. Co-operative. Dev. Seed.	N	N	N	Health Service.	Health Service. Market. Ag. Inputs. Forest Service.
Sahare.	Banking. Developed Seed.	Ag. Ext. Service. Veterinary service. Market.		Market. Ag. Inputs. Co-operative.	Health Service.	Health Service. Market. Ag. Inputs.
Mehelkuna.	Developed Seed.	Ag. Ext. Service. Veterinary service. Market.	N		N	Market.
Gumi	Market. Banking. Co-operative. Dev. seed.	Market.	N	School.	Health Service.	Market.

* These Panchayats are close to fair weather motorable road.
N = Not observed.

(d) The High Ranking Panchayats in the Western Part of the Surkhet District of Nepal

From / To	Babiyachaur*	Kunathari	Salkot	Bidyapur
Babiyachaur		N	Health Service.	Health Service.
Kunathari	N		Health Service.	N

Source: Survey Results.
* Have a service centers, but due to the lack of human and physical resources, the service centers is inactive.
N = Not observed.

Appendix VII. Correlation Matrix of the Variables, Surkhet District of Nepal 1986

Variable*	1 Public Capital	2 Cropping Intensity	3 Land	4 Savings	5 Labour	6 Agricultural Product	7 Capital Formation	8 Capital Stock
Public Capital	1	0.14	-0.31	-0.17	-0.10	0.21	-0.04	0.33
Cropping Intensity		1	-0.16	0.04	0.10	0.22	-0.04	0.13
Land			1	0.45	0.55	0.53	0.18	0.07
Savings				1	0.47	0.46	0.44	0.36
Labour					1	0.80	0.14	0.23
Agricultural Product						1	0.25	0.22
Capital Formation							1	0.94
Capital Stock								1

Source: Survey Results.
* The variables are logarithmic form.

Appendix VIII. Normality Test

To test the normality of the dependent variables K-S one sample test was used. [34]

The K-S one sample test was used here for two reasons. Firstly K-S one sample test treats individual observatios separately, so informations are not lost through the combination of the data categories. Secondly, in comparison to other tests, the K-S test works well in small samples (Siegel, S., 1956). In the individual Panchayats sample size were small, so K-S test was appropriate.

K-S One Sample Test.

To perform the K-S one sample test, the following steps were taken.

1. The theoratical normal distribution function was identified in a cumulative step function(say S_n)

2. The sample, that was going to be tested, were arranged in a cumulative frequency step function, pairing each interval with the theoratical cumulative step function (say S_f).

3. The absolute difference between the theoratical cumulative step distribution function and the sample cumulative step distribution function were calculated.

$$\text{i.e. } D = |S_n - S_f|$$

Where D=Observed Difference between theoratical and sample distribution function.

4. One percent was the level of significance choosen in this study. For one percent level of significance the critical value produced by Siegel, S. (1956). were used.

5. Finally the observed difference (D) was compared with critical value (C) to make the decision.

[34]Adopted from Siegel, S. (1956).

6. Decision Rule: If the observed difference were found greater than the critical value the sample were considered not normal and vice versa.

The Result of the K-S Test of the Dependent variables.

Variables.	Region.	K-S Test.
Private Capital Formation.	Developed.	Normal.
	Less Developed.	Normal.
Value of Agricultural Production.	Developed,	Normal.
	Less Developed.	Normal.

Appendix IX. Chow's Purchase Model

Definition of the variables.

[35] X_t = Per capita desired level of demand for the car at time period t.

X_{t-1} = Per capita stocks of cars at the end of time period t -1

X_{td} = Per capita purchase (demand) of the car in the time period t.

p_t = Price of the car at the time period t.

y_t = Per capita income of the consumers.

e_t = Error term.

b = Depreciation of the car.

The per capita desired level of demand for the car in the time period t is identified as:

$$X_t = a_0 + \alpha_1 p_t + \alpha_2 y_t + e_t \ldots\ldots(1)$$

The purchase of the car in the time period t is :

$$X_{td} = X_t - (1 - b) X_{t-1} \ldots\ldots(2)$$

$$X_{td} = X_t - X_{t-1} + bX_{t-1} \ldots\ldots(3)$$

The purchase of the car X_{td} can be separated into two parts. $X_t - X_{t-1}$ is the desired demand for car in the time period t and bX_{t-1} is the demand for the car for replacement purposes (i e demand for car due to depreciation).

Chow's equation (3) shows the negative effect of X_{t-1} on X_{td} and a positive effect of depreciation on X_{td}. Assuming instantaneous adjustment in the demand for car and substituting right hand side of the eqn. 1 for X_t in eqn. 2 we get:

$$X_{td} = a_0 + \alpha_1 p_t + \alpha_2 y_t - (1 - b)X_{t-1} + e_t \ldots\ldots(4)$$

which is Chow's estimating equation of the demand for cars at the time period t.

The estimating equation of private capital formation in this study is derived similarly as follows.

Definition of the variables.

CS = Per household capital at the end of the year 1981 (Capital Stock).

CF = Demand for capital from 1982 to 1986 (Capital Formation).

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[35]For detail see Chow (1956, p. 49-74).

C = Desired level of capital formation determined by socio-economic constraint (Capital Formation + Capital Stock).

S = Savings of the farm family.

VPC = Value of public capital.

CI = Cropping intensity.

e_t = Error term.

The desired level of capital formation of the farm family is identified as:

$$C = a_0 + \alpha_1 S + \alpha_2 VPC + \alpha_3 CI + e_t \ldots (5)$$

Capital formation from 1982 to 1986 is identified as:

$$CF = C - CS \ldots (6)$$

Note that in this study CS & CF are measured in depreciated value at 1986 prices, therefore accumulation of capital for replacement purpose (or accumulation of capital due to depreciation) is not included. The time period t in this study is five years, so farm families' desire to accumulate capital was expected to adjust in this period of time. Consequently, the adjustment factor is not included in this study.

Substituting the right hand side of equation (5) for C in equation (6) we get:

$$CF = a_0 + \alpha_1 S + \alpha_2 VPC + \alpha_3 CI - CS + e_t \ldots (7)$$

Equation (7) is the basic estimating equation of private capital formation in this study. Equation (7) is expressed in the functional form as in equation (8), to use OLS method of estimating the relationship between dependant and independent variables.

$$CF = F (S, VPC, CI, CS) \ldots (8)$$

Appendix X. Questionnaire

Factors Influencing Capital Formation

in Subsistence Agriculture.

Part 1. Biographic Information.

East: West PSU No.

Gaun Panchayat:

Ward No:

Name:

Age:

Area of the cultivated land: In Ropani: In Bigha:

No. of the family Members:

(a) Under and upto 15 years:

(b) Over 15 and upto 50 years:

(c) Over 50 years:

Years of schooling: No of Years:

Literate: Illiterate:

Enterprises:

(a) Farming.	(b) Side Line.
1. Cereal:	1. Porterage:
2. Milking:	2. Business:
3. Forestry:	3. Service:
4. Fishery:	4. Other:
5. Other:	

Part 2. Information about private capital.

1. How many houses do you have? No.

House/ Houses.	Year built	Cost		Size of the house.	Part use for Econ. Purpose.	Remarks.
		Money in Rs.	Unpaid Labour.			
First. Storeys.				Sq. Meter.	Sq. Meter.	
Second. Storeys.						
Third. Storeys.						

2. Is there any major addition in the house/houses in the last five years?

Yes No If yes: (a). Construction.

Where about of the construction.	Year of the construction.	Cost		Remarks.
		Money in Rs.	Unpaid labour.	
Shed.				

(b) Repair.

Description of the repair	year Repaired.	Cost		Remarks.
		Money in Rs.	unpaid labour.	
Thatching the roof.	In terms of one year.			
Change of materials.				
Plastering or smearing.				

3. Description of the animals.

Animals.	No.	Year Purchased	Reproduced in home	If purchased		Remarks
				Money in Rs.	Paid in Materials.	
Cow.						
She-calf.						
Ox.						
He-calf.						
Buffalo.						
She buffalo calf.						
He-buffalo.						
He-bufallo calf.						
Pig.						
Goat.						
Sheep.						
Chicken.						
Duck.						
Horse.						
Other.						

4. Agricultural Equipment and tools.

Name of the tools.	Year Built or Purchased.	Cost. Money in Rs.	Cost. Unpaid Labour.	Maintenance cost. Money in Rs.	Maintenance cost. Unpaid Labour.	Durability. In years.
Plough.						
Basket.						
Load Carrying Rope.						
Rope.						
Small Hoe.						
Hoe.						
Sickle.						
Axe.						
Wood Scraping Tool.						
Wide Hoe.						
Digger.						
Shovel.						
Big Sickle.						
Wooden Husking Machine.						
Grinder.						
Mat.						
Winnowing Tray.						
Land Smoothing Tool.						
Cane.						
Sack.						
Black Smith.						
Other.						

5. Have you constructed or bought some irrigating facility?

Name.	Year Constructed or Bought.	Cost Money in Rs.	Cost Unpaid Labour.	Maintenance cost Money in Rs.	Maintenance cost Unpaid Labour.	Remarks.
Pump Set.						
Well.						
Storing Facility.						
Control Structure.						
Bund.						
Canal.						
Other.						

6. Have you constructed Drain? Yes No If yes:

Year Build.	Size of it.	Cost. Money in Rs.	Cost. Unpaid Labour.	Maintenance cost. Money in Rs.	Maintenance cost. Unpaid Labour.	Remerks.

7. Have you Constructed a Barn or Thrashing Floor?

Yes No If yes:

Name.	Year Build.	Cost Money in Rs.	Cost Unpaid Labour.	Maintenance cost. Money in Rs.	Maintenance cost. Unpaid Labour.	Remarks.
Barn.						
Thrashing Floor.						

8. Have you constructed cow-shed or store house beside house?

Yes No If yes:

Name.	Year Build.	Cost		Maintenance cost		Remarks.
		Money in Rs.	Unpaid Labour.	Money in Rs.	Unpaid Labour.	
Store.						
Cow-shed. Storeys.						

9. Have you layed orchards? Yes No If yes:

Name of the Plants.	No. of the Plants.	Year Layed.	Cost		Maintenance cost.	
			Money in Rs.	Unpaid Labour.	Money in Rs.	Unpaid Labour.
Guava.						
Papaw.						
Peach.						
Banana.						
Lemon.						
Orange.						
Other.						

10. Have you leveled your land? Yes No If Yes:

Name & Type.	Year Leveled.	Cost		Maintenance cost.		Remarks.
		Money in Rs.	Unpaid Labour.	Money in Rs.	Unpaid Labour	
Irrigated Land						
Non Irrigated Land.						

11. Do you have fence in your field? Yes No If yes:

Have you constructed it? Yes No If yes:

Year Fence Constructed	Length of the Fence In meter.	Cost		Maintenance cost.		Remarks.
		Money in Rs.	Unpaid Labour.	Money in Rs.	Unpaid Labour.	

12. Have you constructed any type of drinking water facility? Yes No If yes:

Year Build.	Useful for Irrigation too.	Cost		Maintenance cost.		Remarks.
		Money in Rs.	Unpaid Labour.	Money in Rs.	Unpaid Labour.	

Part. 3. Information on Production.

A. Irrigated Land.

	Croped Area in Ropani.	Production in Local Unit	Value of the Product.	Remarks
Main crop.				
Second crop.				
Mixed crop with main crop.				
Mixed crop with second crop.				

B. Non Irrigated Land.

	Croped Area in Ropani.	Production in Local Unit	Value of the Product.	Remarks.
Main crop. Second crop.				
Mixed crop with main crop.				
Mixed crop with second crop.				

2. No of Labour used to cultivate land for Ag. production.

Type of Land.	To Prepare Land.	To Sow the Crop.	To Harvest the Crop.	To Store Harvested Crop	Labour to Irrigate Land & Mixed Croping.	Total Number of Labours.
Irrigated Land						
Pair of oxen						
Non Irrigated Land.						
Pair of oxen						

3. Use of the Fertilizer.

Name of the Fertilizer.	Land.	In the 1st. Crop.	In the 2nd. Crop	Total use of the Fertilizer.	Remark.
Manuar in Bamboo Basket (Doko).	Irrigated Land.				
	Non Irrigated Land.				N2 in kg.
Chemical Fertilizer in kg or in Bag.	Irrigated Land.				
	Non Irrigated Land.				

Part 4. Information in connection to adoptationn of modern inputs. Do you use?

	Yes	No	If yes	Qt.	Value.
1. Improved Seed.					
2. Insecticide.					
3. Herbicide.					
4. Pesticide.					
5. Chemical Fertilizer					
6.Modern Ag. Tools.					

Part. 5 Investment in the consumer durables.

1. Schooling of the children. How many childern are in the school? No.

If there are any:

Level.	Attending from Home.	Attending Being out of Home.	Additional Cost to Educate Childern.	Extra Additional Cost due to being off the home.	Total Cost.	Remarks.

2. Purchase of the land right. Have you purchased any land in the last five years?

Yes No If yes:

Year Purchased.	Area of the Land.	Type of the Land.	Cost Money in Rs.	Material.	Remarks.

3. Do you possess?

	Yes	No	Approx. Wt.	Value. 1986 Price.	Remarks.
Gold.					Tola.
Silver.					Tola.
Copper					kg.
Brass.					Kg.
Bronze.					kg.
Radio.					
Watch.					No.
Tape Recorder.					No.
Other					

Part 6. Information in connection to the use of the public capitals.

Public Capital.	Distance in Time.	Use of the Services Per Year. *	Able to Accomplish Services. **	Remarks.
Financial Service (Bank).				Two way time.
Ag. Extension Service.				"
Livestock Service.				"
Medical Service.				"
Ag. Input Corporation.				"
Co-oprative. (Sagha)				"
Drinking Water.				Not Applicable.
Irrigation Facility.				"
Market.				Two way time.
Post office.				"
Forestry	Office.			"
Police	Office.			"
Land tax	Office.			"
Panchayat	Office.			"
Court.				"
Education	Office.			"
Other	Office.			"

*Farm family's effort to get public services.

**Effort of the personnel working for the correspond ing public capital.

7. Are you satisfied with the services provided by the public capitals?

	I do not know.	Yes	No
Financial Service (Bank).			
Ag. Extension Service.			
Livestock Service.			
Medical Service.			
Ag. Input Corporation.			
Co-oprative. (Sagha)			
Drinking Water.			
Irrigation Facility.			
Market.			
Post office.			
Forestry Office.			
Police Office.			
Land tax Office.			
Panchayat Office.			
Court.			
Education Office.			

Part 8. Contribution of the family farmer in the formation of the public capital.

Capital.	Contribution Made by the Farmer			Remark.
	Money in Rs.	Labour.	Material.	
Police Office.				
Post Office.				
High school.				
Middle School				
Primary School				
Fair Weather Motorable Road.				
Track.				
Mule Track.				
Canal.				
Ag. Service Centre.				
Livestock Service Centre.				
Dam.				
Tap.				
Health Post.				
Bridge .				
Plantation .				
Conservation.				
Panchayat.				
Other.				

Part 9. Information of the sales of the farm products and other income.

Goods.	Unit	Sales in the fiscal Year 1985/86. in Rs.
Rice(Paddy).	Muri.	
Maize(Corn).	Muri.	
Wheat.	Muri.	
Millet.	Muri.	
Mustard.	Muri.	
Gram.	Muri.	
Cowpea.	Muri.	
Pea.	Muri.	
Vegetables.		
Tobacco.		
Banana.		
Other Fruits.		
Milk.		
Ghee.	kg.	
Egg.		
Goat.		
Cow.		
Ox.		
Buffalo.		
Chicken.		
Salary.		
<u>Income From</u>		
Porterage.		
Borrowed Money.		
Other Income.		